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INNOVATING WITH CONCEPT MAPPING

Alberto J. Cañas
Priit Reiska
Joseph D. Novak
Editors

7th International Conference on Concept Mapping

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TALLINN UNIVERSITY

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Innovating with Concept Mapping
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Preface

Welcome to CMC2016, the Seventh International Conference on Concept Mapping, and to Tallinn, Estonia.

We returned to Estonia for the seventh edition of the conference as a more mature, experienced community. As participation has expanded and now includes more papers from the Middle East and Asia, we welcomed into our community participants from new countries that had not previously taken part in the conference.

CMC2016 was smaller than previous editions. The financial situation in many parts of the world prevented many authors from attending personally. We opened virtual participation so that they could present their work, and many in the Cmappers community took advantage of this option. But just as with concept maps, smaller is sometimes better. We had the opportunity to get to know each other better, and having part of the conference on a cruise ship to Stockholm helped consolidate our community, both academically and socially

These Proceedings consists of two volumes. Volume 1 was printed by Springer and includes a small set of selected full papers from CMC2016. This Volume 2 contains the rest of the full papers, posters and innovative experiences, including all papers in Spanish and Portuguese.

Once again we had a strong program that covered a variety of topics resulting from the Program Committee's tough time selecting the papers that would be presented orally, virtually or as posters from a large number of high quality submissions. We again thank the members of the Committee for their effort and hard work. And of course, the conference could not have taken place if it were not for all the authors that are willing to share their work with the concept mapping community.

Outstanding invited speakers complemented the high quality of papers: Joseph D. Novak, who will join us via videoconference, Joel J. Mintzes, Jari M. Lavonen, Brian Moon, and Tobias Ley shared their insight, knowledge and experience in their talks.

The Local Organization Committee performed a wonderful job not only with the organization of the Conference, but also making sure we felt at home in Tallinn and on the cruise ship and that we have a great time through the superb social program.

Finally, we thank the sponsors whose support was crucial in making the Conference a reality.

Priit Reiska and Alberto J. Cañas
Co-Chairs, CMC 2016

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AEMC: PROCEDIMIENTO PARA INCRUSTAR UN MAPA CONCEPTUAL EN FORMULARIOS ASOCIADOS A UNA HOJA DE CÁLCULO (FORCAL-MAP)

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Abstract El *Análisis Estructural de Mapas Conceptuales* (AEMC) consiste en un conjunto de técnicas para interpretar y transformar un mapa conceptual en una matriz de asociación o relación. A partir de la sumatoria de matrices individuales se puede obtener una matriz grupal para diferentes tipos de análisis. La modalidad que se plantea en el presente trabajo es el procedimiento para transformar un mapa conceptual en una matriz de asociación mediante formularios de captura insertados en una hoja de cálculo. Lo anterior facilita que un estudiante complete un mapa conceptual por la elección de conceptos que le son proporcionados, y a su vez, registre esta información para ser valorada estadísticamente de acuerdo al AEMC. En este escrito se describe la aplicación de un mapa conceptual presentado a los estudiantes como un formulario de captura en una hoja de cálculo (denominada *ForCal-Map*). Se utilizó el tema del modelo del operón para la construcción de *ForCal-Map,* la cual fue proporcionada a los alumnos mediante una estrategia instruccional establecida. Los criterios de valoración de *ForCal-Map* por parte de los alumnos consistieron en: a) los conocimientos previos que tienen sobre el uso de mapas conceptuales y la hoja de cálculo, b) la funcionalidad del formulario en forma de mapa conceptual, c) el diseño del mapa conceptual en la hoja de cálculo, y d) sus experiencias de aprendizaje al momento de utilizar *ForCal-Map*. Respecto a los resultados, la mayoría de los alumnos consideraron que el uso de *ForCal-Map* es práctico al momento de completar el mapa conceptual. Destaca su agrado acerca del uso de listas desplegables de conceptos, así como el hecho de que el proceso para completar *ForCal-Map* les facilito el estudiar y organizar la información sobre el tema. Los conceptos registrados nos permitieron identificar mediante las frecuencias y porcentajes, al compararlos con el mapa conceptual experto, cuales requieren mayor atención al momento de ser analizados en clase.

1 Introducción

Un mapa conceptual es un gráfico que representa relaciones de significado centradas en un tema o explicaciones específicas acerca del mismo. Está constituido por conceptos, frases de conexión entre conceptos y líneas de conexión; de forma funcional, una frase y línea de conexión expresan la relación direccional y de significado entre dos conceptos. Esta combinación se designa como proposición y es la unidad básica de significado en un mapa conceptual. De esta manera, un mapa conceptual puede proporcionar información de lo que considera importante un estudiante con respecto a un tema. La obtención e interpretación de la información de un mapa conceptual está condicionada con la forma en la cual se construye.

Al respecto Ruiz-Primo (2004) menciona que es posible identificar dos técnicas generales denominadas: "*fill-in-map*" (FM) y "*construct-a-map*" (CM). En esencia, la diferencia radica en el tipo de piezas (conceptos, frases enlaces, líneas de conexión) que son proporcionadas al estudiante para la elaboración del mapa. Algunas investigaciones sugieren que las técnicas FM y CM producen mapas cuya demanda cognitiva no es equivalente debido a la influencia que ejerce la técnica elegida, y por lo tanto, la interpretación de estos dos tipos de mapas puede ser complementaria, pero no semejante. A pesar de ello, ambas técnicas son recomendadas para ser utilizadas en situaciones de aprendizaje y/o análisis del mismo (Ruiz-Primo *et. al*, 2001; Ruiz-Primo, 2004; Yin *et. al.*, 2005).

Una forma específica de aplicar la técnica FM se fundamenta en lo que se denomina como mapa conceptual experto. Este es elaborado por un especialista en un tema, al cual se le quitan algunos elementos (por ejemplo, los conceptos), y esta versión modificada es la que se utiliza. Hay diferentes variantes: el tipo y número de elementos que se quitan al mapa conceptual experto, y de manera consecuente, el número de elementos que se le proporcionan a quien complete el mapa. En un trabajo anterior (Hermosillo *et al,* 2010) propusimos para el ámbito Hispanoamericano el termino de *mapa cerrado* para designar a los mapas conceptuales que son elaborados con la técnica FM, y el término *mapa abierto* para aquellos que son construidos con la técnica CM.

El Análisis Estructural de Mapas Conceptuales (AEMC) aborda principalmente información que proviene de mapas cerrados, y en menor grado de mapas abiertos. Una característica del AEMC es que permite obtener información general y rápida sobre la asociación de conceptos que hace un grupo de alumnos relacionados con un tema. Se basa en herramientas que permiten interpretar y transformar un mapa conceptual en una matriz de asociación o relación. Al sumar las matrices individuales da como resultado una matriz grupal que puede ser utilizada para diferentes tipos de análisis. Otra característica del AEMC es su utilización como instrumento de comparación entre diferentes estrategias de aprendizaje, y directamente como mecanismo de evaluación pretest y postest (González *et al.,* 2006; Hermosillo *et al.* 2010).

De esta forma, la aplicación de AEMC requiere suministrar al alumno un mapa conceptual experto que carece de algunas piezas (conceptos, frases enlaces). Para completar el mapa conceptual cerrado, el estudiante elige las piezas faltantes de una lista de conceptos o conectores (Ruiz-Primo, 2004). Autores como Hernández (2005) consideran que esta lista de piezas evita problemas de equivalencia semántica entre los elementos propuestos por el estudiante y el mapa experto; también sugiere añadir conceptos distractores para minimizar el completado del mapa por azar (Hermosillo *et al.* 2010). La información de cada mapa conceptual convertido en una matriz de conceptos, permite construir un mapa grupal, el cual proporciona datos sobre las frecuencias de mención de cada concepto, ya sea por azar o por certidumbre del estudiante al completar el mapa, y asimismo contrasta hipótesis de tendencias o patrones (González *et al.*, 2006; Hermosillo, *et al*. 2014).

Por lo regular, los datos necesarios para aplicar el AEMC se obtienen de mapas impresos en papel, en los cuales cada alumno seleccionó y escribió los conceptos faltantes. Posteriormente, se requiere capturar en un programa de cómputo los datos de todos los mapas, lo cual implica una inversión adicional de tiempo. En una investigación anterior (Hermosillo *et al.*, 2014), mencionamos la aplicación de una plantilla adaptada a los *formularios en una hoja de cálculo,* para facilitar la captura de la información de los mapas, y generar así las matrices de asociación requeridas. Un avance en este aspecto lo constituiría si el alumno completa el mapa cerrado, y al mismo tiempo se registra de forma digital la información. En este trabajo presentamos los resultados obtenidos en este sentido. El uso de una plantilla, que denominamos como *ForCal-Map* en este escrito, requiere de ser validada en cuanto a su eficiencia de captura y aceptación por parte de los usuarios, que para nuestra investigación son los alumnos. Es transitar del papel a lo electrónico para la aplicación del AEMC.

Para explicar las partes que constituyen *ForCal-Map,* procederemos a exponer qué es un formulario y posteriormente una hoja de cálculo. Un formulario es un documento físico o digital, que se diseña con el propósito de que una persona introduzca una serie de datos en él. La finalidad principal del formulario es almacenar y guardar información recopilada en una matriz o base de datos, para su posterior uso. En el caso de una hoja de cálculo, esta presenta la propiedad de facilitar la generación de listas desplegables, formularios y macros para diseñar una plantilla de captura de datos tipo formulario similar a la plantilla *ForCal-Map* (MEDIAactive, 2013).

Eduteka (2005) define a la hoja de cálculo como un programa diseñado para almacenar, organizar, procesar, presentar y compartir información numérica, textual y gráfica. Butto, Delgado y Zamora (2003) precisan que la hoja de cálculo es un arreglo de filas, numeradas consecutivamente, y columnas, ordenadas en orden alfabético (A, B, C). Una fila y un renglón determinan una celda, a cuyo contenido se tiene acceso desde su dirección, por ejemplo, B3, A25. Las celdas pueden contener texto, números o fórmulas, que pueden hacer referencia a funciones que dependen de una o más celdas a partir de su referencia.

De esta forma una hoja de cálculo es un programa o aplicación que se utiliza para manipular tablas de datos numéricos y alfanuméricos con la ventaja de realizar diferentes tipos de cálculos aritméticos, estadísticos, financieros, mediante el manejo de fórmulas. Una opción adicional es la posibilidad transformar los datos a gráficos. El programa más conocido de creación y gestión de este tipo es el Microsoft Office Excel, el cual es una herramienta que permite al usuario crear sus propios libros o cuentas (MEDIAactive, 2013). Un primer antecedente para adaptar una hoja de cálculo a la estructura de un mapa conceptual fue presentado por Hermosillo *et al.* (2014) quienes construyeron una plantilla con las características de un formulario en un mapa conceptual cerrado con el tema *modelo del operón.* Esta *ForCal-Map se* utilizó para capturar la información de los mapas conceptuales impresos que fueron completados por los estudiantes. La captura de la información de estos mapas sirvió para generar una matriz de datos. La diferencia con el presente trabajo es que la plantilla *ForCal-Map* fue adaptada para ser proporcionada en línea a los alumnos y así: a) resolvieran y completaran el mapa conceptual, y b) se almacenara la información del mapa en la misma plantilla. Asimismo, una vez que el estudiante completó el mapa en *ForCal-Map*, se le instruyó para que resolviera una encuesta, la cual permitió analizar los comentarios y puntos de vista de los estudiantes, con relación al diseño y funcionalidad de este instrumento.

Para dar continuidad al desarrollo de *ForCal-Map*, el tema empleado para su aplicación también fue el modelo del operón, el cual explica cómo se regula a nivel molecular la actividad genética en procariontes. El programa de la asignatura de Biología V de la Escuela Nacional Preparatoria (ENP) incluye este contenido. Desde el enfoque de la enseñanza de las ciencias, el modelo del operón es un reto de comprensión para los alumnos al ser abstracto. Castro (2011) señala que para el estudio de temas moleculares se puede recurrir a la construcción y comprensión con modelos.

Considerando el uso de *ForCal-Map,* asociado al AEMC, como un procedimiento para obtener y transformar de forma eficiente la información de un mapa conceptual, el presente trabajo se enfoca en realizar un análisis preliminar acerca de su uso por parte de los alumnos. El análisis se centra en explorar el punto de vista estudiantil con relación a los conocimientos que tienen sobre: a) el uso del mapa conceptual y la hoja de cálculo, b) la funcionalidad del formulario en forma de mapa conceptual, c) el diseño del mapa conceptual en la hoja de cálculo, y d) su experiencia de aprendizaje. La información obtenida permitirá validar y valorar *ForCal-Map* con relación a las características de su funcionalidad como mecanismo para generar, capturar y procesar un mapa conceptual, situación que es relevante para el uso de AEMC.

2 Metodología

2.1 Población Estudiada

La población que participó en esta investigación estuvo constituida por 56 estudiantes, con una proporción de 46% de sexo femenino y 54% de sexo masculino. La edad de los alumnos osciló entre los 17 y 18 años. La población estaba dividida en tres grupos escolares que cursaban el 6º ciclo de bachillerato en el área Químico-Biológicas, en el plantel 2 de la ENP, el cual forma parte de la Universidad Nacional Autónoma de México (UNAM). Se consideraron los resultados de los tres grupos como una sola muestra, ya que el propósito principal de la investigación es analizar de forma preliminar la validez interna del uso de *ForCal-Map* al momento de ser empleada por los estudiantes.

2.2 Desarrollo de la Estrategia

La estrategia incluyó tres actividades. En primera instancia, los alumnos iniciaron con la lectura extra clase de un fragmento del libro "Genética: la continuidad de la vida" de Barahona y Piñero (1994). El tema que revisaron los alumnos fue *Regulación y control genético: el modelo del operón,* que se encuentra en el capítulo III "Mirando dentro del gene". La indicación fue que leyeran la información ya que ésta sería útil para elaborar un mapa conceptual.

Como segunda parte de la estrategia, se indicó a los alumnos que descargaran un archivo que incluía la plantilla *ForCal-Map*. La instrucción fue que completarán el mapa conceptual que se encontraba en el archivo descargado y debía ser capturado de acuerdo a las instrucciones incluidas. Al término de la captura, los estudiantes regresaron el archivo vía correo electrónico. Posteriormente se añadió y organizó la información en una sola hoja de cálculo. La tercera etapa de la estrategia consistió en el llenado de una encuesta en línea, por parte de los alumnos, la cual sirvió para evaluar el uso de *ForCal-Map* en cuanto a su funcionalidad y diseño.

2.3 Diseño del Mapa Conceptual Cerrado y la Plantilla ForCal-Map.

Se utilizó el mapa conceptual experto elaborado por Hermosillo *et al.,* (2014). Este mapa conceptual se construyó a partir del documento de lectura de Barahona y Piñero (1994). El mapa conceptual utilizado presenta una arquitectura consistente en óvalos para completar conceptos, tres conceptos que funcionan como organizadores previos, así como las frases enlaces específicas entre los 21 conceptos que forman el mapa del operón (Figura 1). De manera paralela se elaboró una lista de 24 palabras ordenadas alfabéticamente; 18 corresponden a los conceptos del mapa experto y 6 conceptos distractores. La lista se incluyó como parte de los formularios insertados en *ForCal-Map.*

Posteriormente la arquitectura del mapa conceptual del modelo del operón se transfirió a una hoja de cálculo. En específico se eligió el programa de Excel para generar *ForCal-Map*. Aunque existen otros programas que permiten relacionar formularios con una hoja de cálculo (como la plataforma de Google Drive y OpenOffice), al momento de escribir esto no habría forma de adaptar el formulario a una estructura tipo mapa conceptual. Por lo cual *ForCal-Map* fue construido con base en la hoja de cálculo de Excel.

El entramado de filas y columnas permitió ubicar espacialmente las casillas de los conceptos, haciendo uso de las celdas. Con la opción de *Herramientas de Dibujo* se procedió a dibujar las líneas, conectores de enlace, campo de captura de datos personales, así como las instrucciones (figura 2). A la celda que le fue asignado un concepto se le incluyó una lista despegable con los 24 conceptos a seleccionar. El alumno solo podía elegir un concepto, y éste se insertaba en la casilla correspondiente. Se elaboró una *macro* que permitió transferir los conceptos colocados en las casillas a una base de datos en una segunda hoja de trabajo de la hoja de cálculo. La información que generó cada alumno en su archivo de captura se transfirió a otro archivo que permitió construir una base de datos con los conceptos que fueron seleccionados.

2.4 *Elaboración de la Encuesta*

Se diseñó y construyó una encuesta con 15 preguntas, la mayoría cerradas, para evaluar el uso de *ForCal-Map* en un contexto educativo. Las preguntas de la encuesta se muestran en las tablas 1, 2, 3 y 4. Se utilizaron cuatro criterios para su elaboración que fueron: a) conocimientos previos sobre el uso de mapas conceptuales y hojas de cálculo, b) funcionalidad del formulario en forma de mapa conceptual digital, c) diseño del mapa conceptual en la hoja de cálculo, y d) experiencia de aprendizaje al hacer uso del formato digital.

El primer criterio se basó en diagnosticar los conocimientos de los alumnos con relación al diseño, elaboración y/o uso de mapas conceptuales, así como el empleó de hojas de cálculo. El segundo criterio se enfocó a la parte operativa y funcional que puede tener *ForCal-Map* al ser completado mediante listas desplegables. El tercer criterio se centró en el diseño de *ForCal-Map* con relación al uso de colores, formas de las casillas de captura de conceptos, forma de las líneas y conectores, utilización de campos de captura de datos personales y área de instrucciones. El cuarto criterio consideró el punto de vista de los estudiantes con base en la experiencia de aprendizaje que tuvieron al hacer uso de *ForCal-Map*. Este último criterio incluyó tres preguntas abiertas que permitieron a los alumnos argumentar sobre sus puntos de vista relacionados con su experiencia al momento de completar el mapa, haciendo uso de los conocimientos adquiridos con relación a la lectura recomendada.

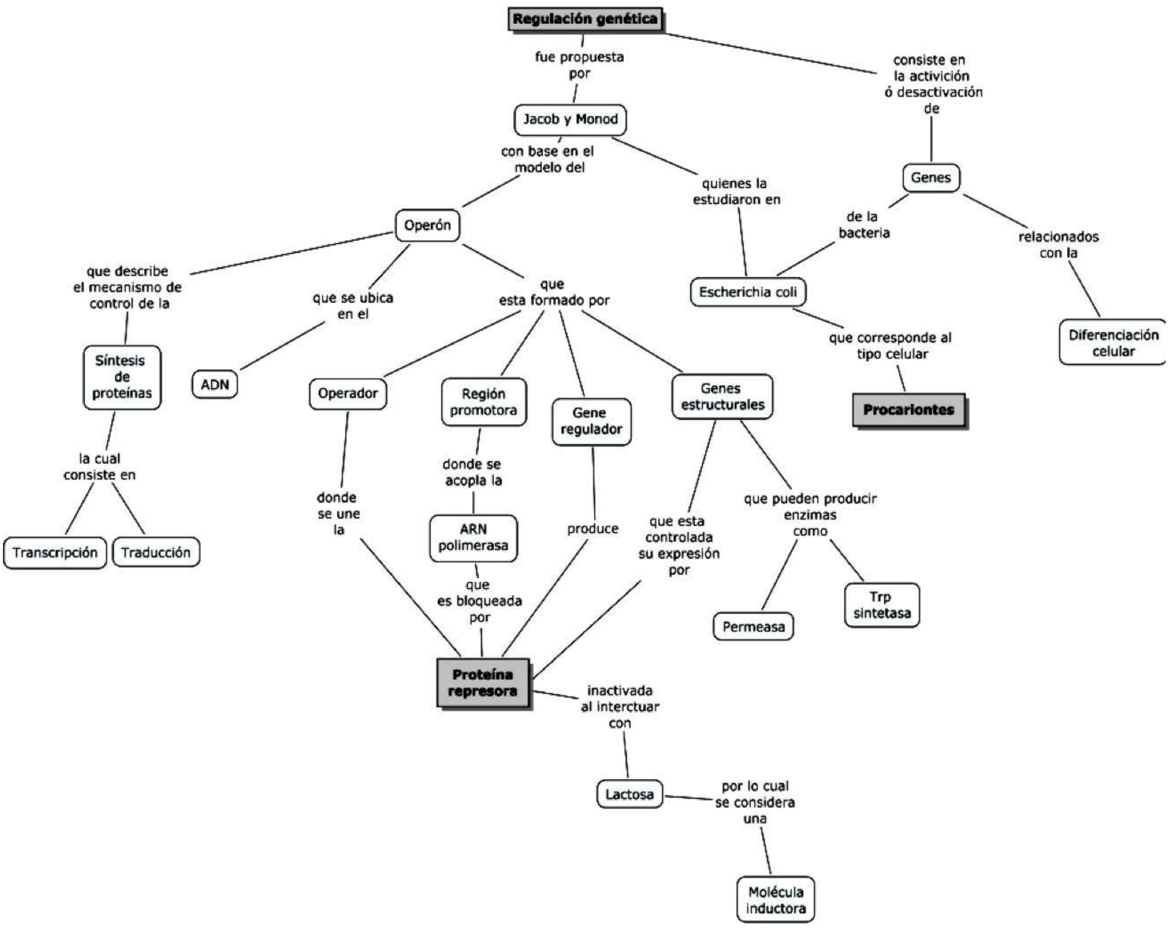

Figura 1. Mapa conceptual cerrado experto. Las casillas sombreadas corresponden a conceptos que permanecieron en *ForCal-Map*.

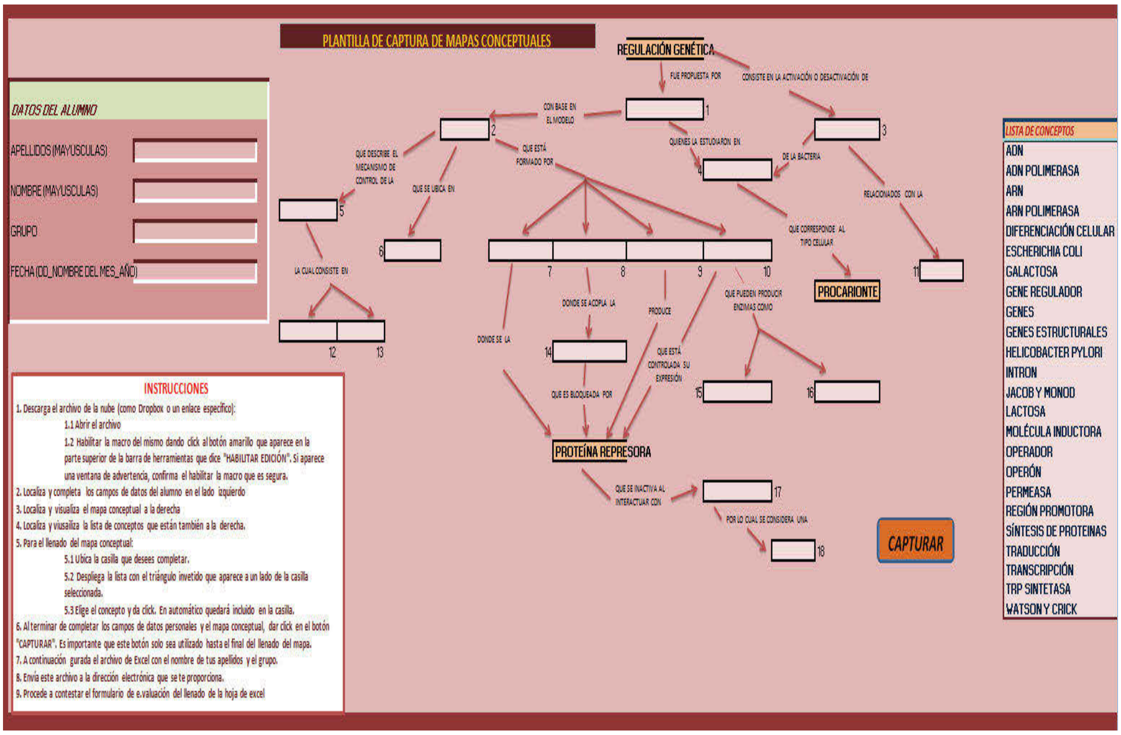

Figura 2. Detalles en el diseño del mapa conceptual de la plantilla *ForCal-Map.* En la imagen se muestra la plantilla completa con los campos de datos personales, instrucciones, lista de conceptos y área de captura del mapa.

3 Resultados

En la tabla 1 se muestran los resultados de la encuesta sobre habilidades previas que tienen los alumnos en el uso de mapas conceptuales y la hoja de cálculo. Más del 50% de los estudiantes conoce los mapas desde la educación primaria o secundaria, y solo 30% indicó que su primer contacto con los mapas conceptuales ocurrió en este ciclo escolar. Otro dato fue que 37% transcribe sus mapas conceptuales a un programa especializado, como CmapTools (Cañas et al, 2004). Con relación al uso de hojas de cálculo, 73% las conoce desde la educación primaria o secundaria.

Cuestionamiento	Respuestas con mayor frecuencia	Porcentaje de respuesta
HABILIDADES PREVIAS (Utilización de mapas conceptuales y hoja de cálculo)		
Los mapas conceptuales los he manejado	Desde la primaria o secundaria	53
	A partir de este ciclo escolar.	30
El procedimiento que empleo para elaborar mapas conceptuales es:	Hacerlos a mano y después transcribirlos con un programa de cómputo especializado en mapas (ejemplo: Cmaptools)	37
	Hacerlos a mano; nunca utilizo programas de cómputo para su construcción	27
	Hacerlos a mano y después transcribirlos con un programa de cómputo NO especializado en mapas (ejemplo: Word o Power Point)	18
En relación a la hoja de cálculo del programa Excel	Lo había visto o manejado en la primaria o secundaria	73

Tabla 1: Porcentajes de respuestas a las preguntas relacionadas con habilidades previas en el uso de mapas conceptuales y hojas de cálculo.

Los resultados de las frecuencias de las respuestas a las preguntas relacionadas con la funcionalidad de la plantilla *ForCal-Map* se muestran en la tabla 2. Más del 80% señaló facilidad en el manejo de *ForCal-Map* con relación a la descarga de archivo, uso de instrucciones, llenado de datos personales y captura de la información.

Cuestionamiento	Respuestas con mayor frecuencia	Porcentaje de respuesta
FUNCIONALIDAD (Captura de datos en el mapa conceptual de la hoja de cálculo)		
La descarga del archivo de Excel fue	Muy fácil o fácil	91
El completado de tus datos fue	Muy fácil o fácil	93
Para resolver el mapa conceptual	Primero leí todas las instrucciones y después lo resolví	82
Las instrucciones son	Fáciles o Muy fáciles de seguir	95
La operación de seleccionar el concepto de la lista despegable y darle click fue	Muy fácil o fácil	92
La operación de finalizar (CAPTURA) fue	Muy fácil o fácil	80

Tabla 2: Porcentajes de respuestas a las preguntas relacionadas con funcionalidad de *ForCal-Map*

En la tabla 3 se observan los resultados obtenidos sobre los porcentajes de las respuestas afines con el diseño de *ForCal-Map*. Un poco más del 50% le fue indistinto el uso de colores y el tipo de letra; sin embargo, para esta última categoría, 42% señaló que el tipo de letra les facilitó completar el mapa conceptual.

Cuestionamiento	Respuestas con mayor frecuencia	Porcentaje de respuesta
DISEÑO (mapa conceptual en la hoja de cálculo)		
La combinación de colores de la hoja de Excel	Te fue indiferente al momento de completar del mapa conceptual.	62
El tipo de letra de la hoja de Excel	Te fue indiferente al momento de completar del mapa conceptual	57
	Facilitó el completado del mapa conceptual	42
La estructura y formas en las que se te presento el mapa conceptual	Facilitó el completarlo	62

Tabla 3: Porcentaje de las respuestas a las preguntas relacionadas con el diseño de *ForCal-Map*

La tabla 4 presenta los resultados porcentuales de las respuestas a los cuestionamientos relacionados con la experiencia de aprendizaje de los estudiantes al usar *ForCal-Map*. Más del 80% de los alumnos les pareció agradable la experiencia, señalando que tiene muchas ventajas por lo cual la volverían a utilizar.

Cuestionamiento	Respuestas con mayor frecuencia	Porcentaje de respuesta
EXPERIENCIA DE APRENDIZAJE (0pinión personal)		
El completar un mapa conceptual de esta manera te resulto	Agradable	87
Consideras que completar un mapa conceptual de esta manera	Tiene muchas ventajas	83
¿Te agradaría volver a completar un mapa conceptual de esta manera?	Si	95

Tabla 4: Porcentaje de las respuestas a las preguntas asociadas con la experiencia de aprendizaje al utilizar *ForCal-Map.*

Las figuras 3, 4, y 5 muestran el análisis de las preguntas abiertas en donde los alumnos señalaron sus puntos de vista sobre la experiencia de aprendizaje que tuvieron con *ForCal-Map.* Con relación a las repuestas a la pregunta abierta sobre cómo les resulto el completar un mapa conceptual haciendo uso de *ForCal-Map* (figura 3), 32% destacó la facilidad y practicidad que le proporcionó el uso de listas desplegables de conceptos para la colocación de los mismos en las celdas correspondientes. Otro 17% señaló que le permitió repasar y estudiar los conceptos relacionados con el tema.

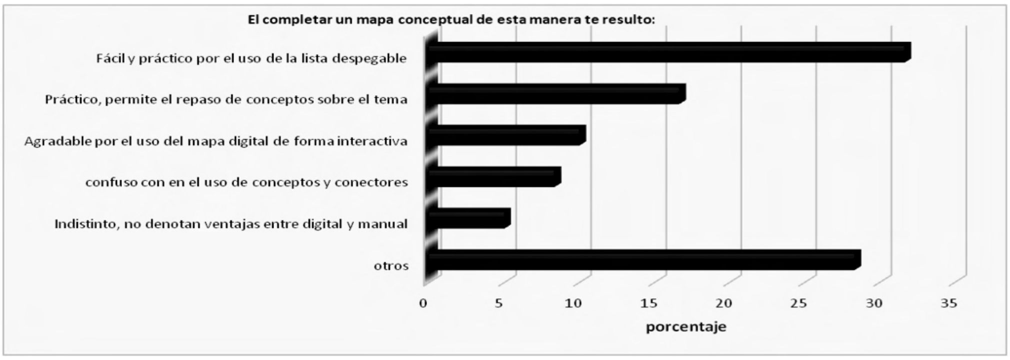

Fig. 3. Porcentaje de las categorías de respuestas al cuestionamiento: "El completar un mapa conceptual de esta manera te resulto"

En la figura 4 se muestra el porcentaje de respuestas al cuestionamiento: "considera que completar un mapa conceptual de esta manera"; al respecto 28% de los alumnos señaló que le facilitó revisar y analizar el tema planteado en la lectura, 20% consideró que se facilitó el registró de la información y 12% destacó otra vez la facilidad que brinda el uso de listas desplegables de conceptos en las casillas correspondientes en donde va un concepto determinado, según el mapa conceptual experto.

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Fig. 4. Porcentaje de las categorías de respuestas al cuestionamiento: "Considera que completar un mapa conceptual de esta manera"

Respecto a las respuestas a la pregunta ¿Te agradaría volver a completar un mapa conceptual de esta manera?, 21% de los estudiantes destacó, al igual que el cuestionamiento anterior, las facilidades que brindó el formato de *ForCal-Map* para hacer repaso del tema, además de organizar la información. Asimismo 18% señaló que fue práctico y facilitó la labor del alumno al momento de completar el mapa conceptual. Otro 16% mencionó que es un formato agradable. Con relación a comentarios negativos sobre el uso de *ForCal-Map,* menos del 7% de alumnos destacó, en los tres cuestionamientos de las figuras 3, 4 y 5, confusión en la redacción de algunos conectores y la ubicación de conceptos dentro del mapa conceptual cerrado, por lo cual nosotros inferimos que quizá es consecuencia de la falta comprensión del tema, más que de lo inexacto de los conceptos y conectores.

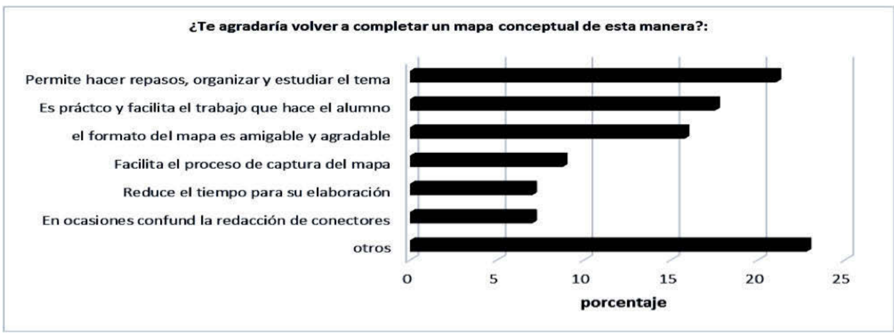

Fig. 5. Porcentaje de las categorías al cuestionamiento:" ¿Te agradaría volver a completar un mapa conceptual de esta manera?"

Para una mejor comprensión e interpretación de la ubicación de las frecuencias porcentuales en el mapa conceptual experto, se respetó la división en dos regiones que sugirieron Hermosillo *et al.* (2014), respecto a la información que presenta el mapa; estas regiones corresponden a: 1) *los antecedentes del tema regulación genética* y 2) a *la descripción de la estructura del modelo del operón*.

Para la primera región, solo el concepto de *Diferenciación celular* presenta un porcentaje de 69% de ser colocado de manera correcta, los demás conceptos fueron colocados correctamente por arriba de 88%. Para la segunda región, los conceptos *Operador, Región promotora, ARN polimerasa, Permeasa y Trp sintetasa* presentan porcentajes entre 51 y 75% en cuanto a ser ubicados correctamente, los demás están por arriba de 85%.

4 Discusión

Una etapa importante en el desarrollo de la técnica AEMC es la utilización de mapas conceptuales cerrados como una forma de recopilar información sobre un tema que se desea explorar. La evaluación de *ForCal-Map* con el tema del modelo del operón proporcionó información relevante para su uso subsecuente. La mayoría de los alumnos consideró agradable y práctico el utilizar un mapa conceptual adaptado a un formulario de captura de información inserto en un formato de hoja de cálculo. El uso de los conceptos a manera de listas desplegables en las casillas fue atractivo para los estudiantes por la facilidad que les brindó al momento de completar el mapa insertado en *ForCal-Map*.

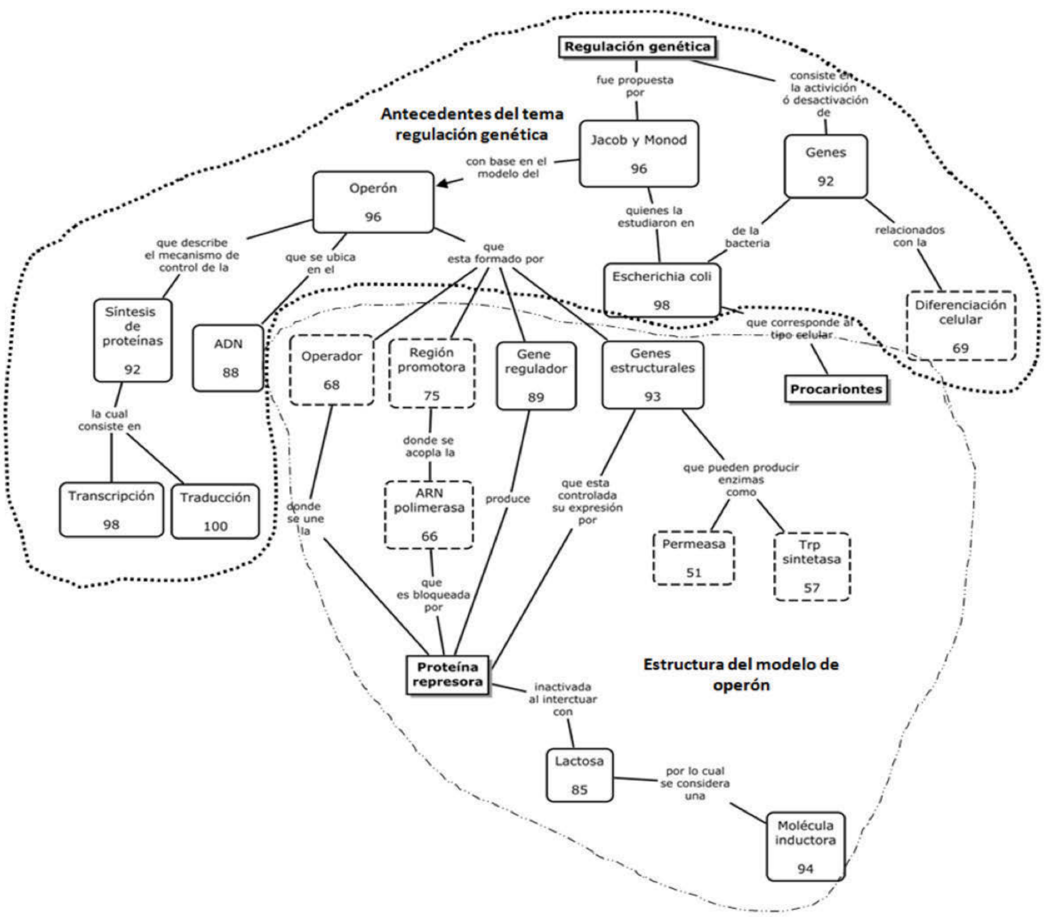

Fig. 6. Mapa conceptual cerrado experto que presenta los porcentajes de los conceptos elegidos por los alumnos al usar *ForCal-Map*.

Algunos alumnos destacaron en sus comentarios la facilidad de elegir y completar conceptos en *ForCal-Map* en comparación con la elaboración de un mapa abierto que demanda otro tipo de habilidades cognitivas para su construcción. Ruiz-Primo (2004) destaca las bondades e inconvenientes en la utilización de mapas conceptuales abiertos y cerrados. Quizá los comentarios de los alumnos se fundamentan desde su perspectiva, en la reducción de tiempo y esfuerzo cognitivo que brinda el completar *ForCal-Map*, comparado con la construcción de un mapa conceptual abierto. Cuando se tienen grupos numerosos de alumnos, cómo es nuestro caso, se dificulta el analizar mapas conceptuales abiertos por la demanda en tiempo que requieren para su revisión y retroalimentación. De esta forma el empleó de un mapa conceptual cerrado, en este caso de manera digital con *ForCal-Map*, puede facilitar la recopilación, interpretación y retroalimentación a un grupo numeroso.

Al respecto, destacamos los comentarios de los estudiantes referidos a que el uso de *ForCal-Map* les permitió estudiar y hacer repaso del tema. Por otra parte, consideraron que insertar los conceptos en el mapa conceptual no fue una labor fácil, por lo que algunos recurrieron a la consulta de otras fuentes bibliográficas sin habérselo mencionado. Esta actividad aparentemente promueve una demanda cognitiva mayor al momento de completar el mapa, sin embargo, requerirá de ser analizado en investigaciones posteriores para poder afirmarlo.

Con relación al aspecto afectivo de los alumnos al emplear *ForCal-Map*, ellos señalaron que fue una estrategia interesante para aprender sobre un tema escrito y que volverían a repetirla porque les gustó. Quizá el empleo de mapas cerrados con el auxilio de *ForCal-Map,* puede preceder al uso de mapas abiertos, como un factor motivador. En contraste 7% denotó descontento porque consideran que es confuso el uso de ciertos conectores y conceptos en la plantilla; una interpretación sobre esta confusión es que quizá refleja problemas de comprensión del modelo de operón más que con la estructura del mapa conceptual insertado en *ForCal-Map*.

El desarrollo de la estrategia, que consistió en la lectura del documento del modelo del operón y posterior completado de *ForCal-Map,* fueron actividades extraclase. Esto difiere de lo realizado por Hermosillo *et al.* (2014), ya que ellos solicitaron a los estudiantes realizar la lectura extraclase, y posteriormente ocurrió en el salón de clases el completado del mapa en un formato impreso. Comparando los porcentajes de completado en las casillas en ambas situaciones, se observa que los valores mínimo y máximo de porcentajes fueron mayores, 51% y 100%, comparado con los obtenidos por Hermosillo *et al.* (2014) que fueron de 12% y 85% respectivamente. Quizá el uso de *ForCal-Map* influyó en los valores obtenidos, pero se requiere realizar una investigación específica que oriente esta posible hipótesis. Por otra parte, se establece coincidencia en los conceptos que les fueron difíciles de ubicar correctamente como son: diferenciación celular, operador, región promotora, ARN polimerasa, permeasa y Trp sintetasa. El considerar estos conceptos que presentaron dificultades en su ubicación correcta en *ForCal-Map*, permitió orientar los esfuerzos de los docentes para efectuar, en una clase posterior, un análisis detallado del significado de estos conceptos en el modelo de operón.

5. Conclusiones

La utilización *ForCal-Map* por los alumnos permitió reorientar y validar su uso como parte de AEMC. Los alumnos destacan la parte lúdica de *ForCal-Map* debido a que les resulto agradable y práctica. Se destaca facilidad al momento de ser completada por su diseño y uso de herramientas como son las listas desplegables de conceptos. La utilización de *ForCal-Map* posibilita la diversificación de actividades de aprendizaje por favorecer el interés de alumnos para estudiar y organizar la información referente al tema de estudio. La información que se pueda generar con relación al uso de mapas conceptuales cerrados en formato digital, como es el caso de *ForCal-Map*, permitirá a los autores realizar las modificaciones y ajustes necesarios al AEMC, de tal manera que se pueda tener una mayor eficacia al ser aplicada en situaciones escolares con grupos numerosos, como es nuestro caso.

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APORTACIÓN METODOLÓGICA AL MODELO MCAC PARA EL ANÁLISIS CUALITATIVO MEDIANTE MAPAS CONCEPTUALES

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Abstract. El presente artículo muestra los resultados de una investigación que tuvo por objetivo describir las concepciones docentes sobre la enseñanza que prevalecen en profesores universitarios de la Facultad de Ciencias Sociales de la Universidad Autónoma de Chiapas. Para tal fin se recurrió al uso del mapa conceptual como una técnica de análisis de datos cualitativos que permitiera evidenciar las premisas que conforman el pensamiento de los profesores en torno a la enseñanza. Utilizando el Procedimiento de Mapeo Conceptual para el Análisis Cualitativo (MCAC) se construyeron una serie de mapas conceptuales que buscan ser reflejo del pensamiento del profesor en torno a la enseñanza. La validación de los mapas por parte de los profesores entrevistados permitió la observación de elementos faltantes y la reorganización de algunos de los mapas. Se sugiere la incorporación de este paso al modelo de mapeo para el análisis de datos cualitativos a fin de dotarlo de mayor fiabilidad.

1 Introducción

Las concepciones de los profesores es un tema que ha sido estudiado principalmente desde la psicología educativa. Desde los años 70 pueden hallarse trabajos cuya preocupación central es comprender la manera en que el docente toma decisiones (Feldman, 2008) sin embargo, en épocas más recientes se ha buscado comprender el pensamiento del profesor desde diferentes enfoques o bajo diferentes situaciones como lo son las teorías implícitas, representación de nociones o bien de teorías personales (Aguilar Tamayo & Montero Hernández, 2010).

Las concepciones pueden ser entendidas como aquellos significados especiales que los docentes otorgan a un fenómeno (Feixas, 2010) son la forma en que las personas entienden el mundo, la manera en que éste funciona y el papel que juegan en él, son pues, construcciones personales que relacionamos con un contexto específico y que nos permiten dotar de significado a todo aquello que nos rodea. Las concepciones suelen adquirirse a través de las formas culturales con las que tenemos contacto y pueden generar un arraigo y cierta resistencia a cambiar la percepción que se tiene sobre un fenómeno o situación con la que estamos en contacto, esto es lo que de la Cruz (2014) y otros conciben como huella identitaria.

El ámbito educativo no es la excepción, tanto maestros como estudiantes van construyendo ideas asociadas al papel que ellos y los otros desempeñan, a través de la experiencia vivida en las aulas y los contextos de educación, ambos sujetos van conformando sus propias ideas de lo que supone enseñar y aprender. Si bien, las concepciones en su mayoría integran un conocimiento subjetivo y no sistemático, éstas pueden incluir también al conocimiento experto o al conocimiento sistemático, pero que se encuentra integrado a esquemas de acciones orientadas a resolver problemas en una situación cotidiana.

En este trabajo se describe la aplicación de un modelo de análisis de datos basado en la construcción de mapas conceptuales a partir de entrevistas semiestructuradas para analizar las concepciones de los profesores universitarios de la Facultad de Ciencias Sociales de la Universidad Autónoma de Chiapas (UNACH) a partir entender cuatro dimensiones del concepto de enseñanza: la forma en que se concibe al estudiante, cómo se organizan y estructuran los contenidos, los propósitos que los profesores le otorgan a la evaluación y a las actividades de aprendizaje que proponen. En él se describe y discuten las concepciones de los profesores en el contexto de los modelos clásicos de enseñanza y frente a los nuevos paradigmas como el constructivista o de la psicología cognitiva. Por ejemplo, el de La Nueva Cultura Educativa propuesto por Juan Ignacio Pozo (2002, 2009, 2014).

2 Metodología

Centrado en la búsqueda de una herramienta metodológica que le permitiera resolver problemas de su propia investigación; en 1972 Novak propuso una herramienta mediante la que se pudieran establecer relaciones entre diferentes conceptos a través de una estructura proposicional. El mapa conceptual permitía representar de manera ordenada las ideas derivadas de los discursos de los sujetos que participaban en dicha investigación. En este sentido puede observarse que el mapa conceptual "en su origen es una técnica de investigación para el análisis de datos recogidos en las entrevistas" (Aguilar Tamayo, 2012).

Debido a que los mapas conceptuales "son herramientas de representación de los marcos conceptuales-proposicionales y de significado que se poseen para un concepto o grupo de conceptos" (Novak, 1998) son una herramienta ideal para la representación de las concepciones de los profesores, ya que, las concepciones, al ser parte de los marcos del pensamiento de la persona pueden ser identificadas a través de premisas, afirmaciones o proposiciones.

Para hallar el significado que una persona ha construido respecto a un concepto es necesario poder encontrar todas las relaciones establecidas entre ese y otros conceptos, se hace entonces necesario navegar entre una serie de proposiciones e ir hilando las relaciones que se entretejen entre cada una de ellas. Son estas razones las que permiten elegir al Mapa Conceptual como una herramienta para el análisis de los datos de esta investigación que se desprenden de entrevistas semiestructuradas aplicadas a profesores universitarios.

2.1 Mapeo Conceptual para el Análisis Cualitativo

Existen varios trabajos en los que se recupera el uso del mapa conceptual para el análisis de entrevistas o bien, para la reducción de datos (Aguilar Tamayo & Montero Hernández, 2010). De manera creciente se pueden encontrar investigaciones en las que el mapa conceptual no solamente es útil como una herramienta analítica en la construcción de marcos conceptuales o de comprensión de la teoría. Trabajos como los de Ponce de León, Aguilar Tamayo y Montero Hernández (2004); García Salgado (2013) y Villalobos Hernández (2011, 2015) estos autores enfatizan que el mapa no ha sido utilizado como un instrumento de recolección de datos, sino como un procedimiento para su análisis.

Por su parte, Cuenca (2014) ha desarrollado un modelo para el análisis de datos a través del mapa conceptual al que llamó "*Procedimiento de Mapeo Conceptual para el Análisis Cualitativo*" (MCAC) Los trabajos de Cuenca se centran en la recolección de las experiencias de expertos de diferentes países en el uso del mapa conceptual, especialmente, que han utilizado esta técnica para analizar datos en investigaciones de carácter cualitativo.

A través de la comparación de sus procedimientos, Cuenca pudo obtener una serie de regularidades a partir de las que plantea un modelo que se compone de los siguientes elementos:

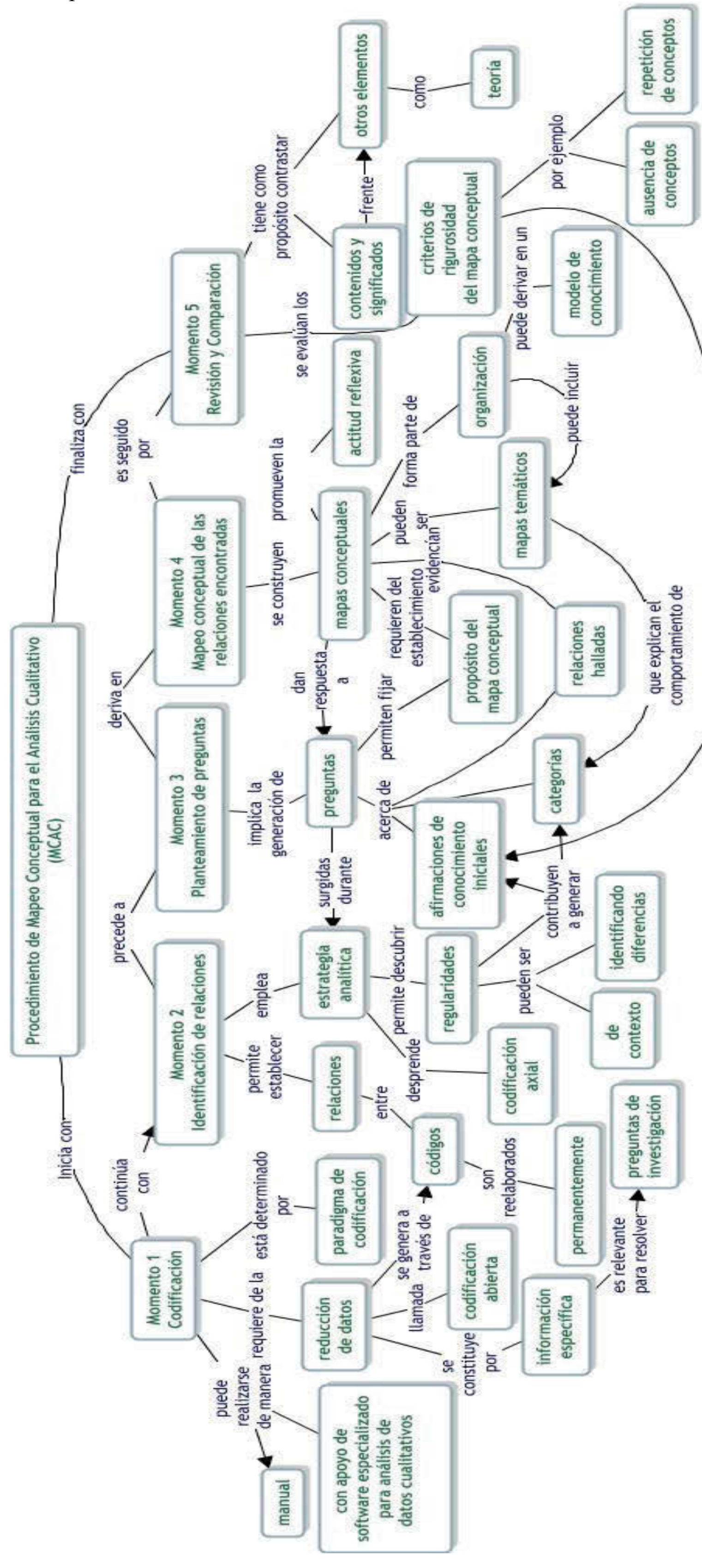
1. Codificación
2. Identificación de relaciones
3. Planteamiento de preguntas
4. Mapeo conceptual de las relaciones encontradas
5. Revisión y comparación

Como es posible apreciar, este modelo es aplicable una vez que los datos han sido recolectados y ordenados. El modelo comparte algunos elementos con otros métodos de análisis de datos cualitativos como el de Gibbs, pero se distingue por la particularidad de la elaboración de los Mapas Conceptuales (Cuenca, 2014) como parte de la identificación de relaciones subyacentes en los datos analizados.

Para efectos de esta investigación la recolección de datos se realizó mediante entrevistas semiestructuradas aplicadas a profesores seleccionados a través del método de bola de nieve. Una vez ordenadas y transcritas las grabaciones se dio inicio al proceso de codificación, sustentado en la teoría de la que se desprende el trabajo. Sin embargo, aún hacía falta encontrar el sentido de los datos.

Debido al potencial que tiene el mapa conceptual para la representación de conocimiento se optó por realizar el análisis de las entrevistas a través del modelo propuesto por Cuenca, por tal motivo, una vez concluido el proceso de codificación y categorización a través del software Atlas Ti, el siguiente paso consistió en la identificación de relaciones, entre los conceptos y códigos descritos por los profesores, es importante destacar que algunas de estas relaciones pudieron ser identificadas de manera temprana, incluso desde la codificación, sin embargo, algunas otras no eran tan evidentes a primera instancia por lo que se requirió de una lectura mucho más cuidadosa.

A continuación, se presenta un mapa conceptual que ilustra cada uno de los momentos en que se divide el MCAC y las acciones implementadas en ellos.



Mapa 1. Procedimiento de Mapeo Conceptual para el análisis Cualitativo (MCAC) fuente: Cuenca Almazán, 2014. Se describe la el Procedimiento de Mapeo Conceptual para el Análisis Cualitativo (MCAC) desarrollado por Cuenca (2014) pueden distinguirse los cinco momentos partiendo de la codificación, hasta la revisión y comparación de los Mapas Conceptuales construidos a partir de los datos. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1PN34XKVY-M9P3HK-15SDTX.

Durante esta etapa se encontraron algunas regularidades en los discursos de los profesores, así como una serie de premisas que permitieron plantear las primeras preguntas para su organización en mapas conceptuales. A partir de los códigos se desprendieron 8 preguntas de enfoque: 7 relacionadas con las categorías de análisis y una más que tiene que ver con el perfil del docente.

Una vez teniendo claras las preguntas de enfoque se dio inicio a la construcción de los mapas conceptuales, en ellos se integraron las afirmaciones expresadas por los profesores; es importante señalar que en algunas ocasiones el discurso del profesor se estructuró de manera proposicional y estas expresiones se incorporaron al mapa de manera fiel, sin embargo en otros momentos la afirmación estaba implícita en varios de los fragmentos de la plática y la proposición fue construida por la investigadora. Al final de esta etapa se obtuvieron 40 mapas conceptuales que buscan representar el pensamiento de cada uno de los profesores respecto a los conceptos de enseñanza, aprendizaje, conocimiento, estudiante, evaluación, planeación y autoconcepción docente, así como un mapa del perfil de cada uno de los participantes en la investigación.

Finalmente fueron construidos 7 mapas más que agrupaban las visiones compartidas entre los profesores. Estos fueron elaborados a partir de la comparación de los mapas individuales mediante la herramienta "comparar un Cmap" del programa Cmap Tools, lo que permitió ir verificando los conceptos y proposiciones comunes entre los mapas individuales al mismo tiempo que se identificaban las diferencias entre el pensamiento de cada profesor.

Novak (1998) señala que pueden encontrarse tres tipos de proposiciones: Válidas, no válidas y absurdas. A pesar de que en la representación del conocimiento científico el mapa conceptual busca establecer únicamente afirmaciones de verdad, dado que este trabajo tiene como objetivo la representación de un conocimiento subjetivo de los maestros universitarios, es posible encontrar afirmaciones tanto no válidas como absurdas que formen parte del pensamiento de los profesores y deban ser integradas al mapa conceptual. Otra licencia que se ha tomado respecto al manejo de la técnica es la inclusión negaciones, esto debido a que su transformación en afirmación podría cambiar el sentido de lo expresado por el profesor.

2.2 Validación de Mapas Conceptuales por parte de los informantes

Un aporte de esta investigación al modelo MCAC es la validación de los mapas conceptuales por parte de los informantes. Debido a que la investigación pretendió reflejar el significado del concepto de enseñanza desde la visión del profesor, se consideró relevante someter los mapas realizados por la investigadora a la evaluación y escrutinio por parte de los docentes entrevistados. Esto permitió dotar a la investigación de un mayor grado de confiabilidad al mismo tiempo que abrió un espacio reflexivo que permitió a los maestros identificar elementos presentes en su práctica educativa de los que no eran conscientes.

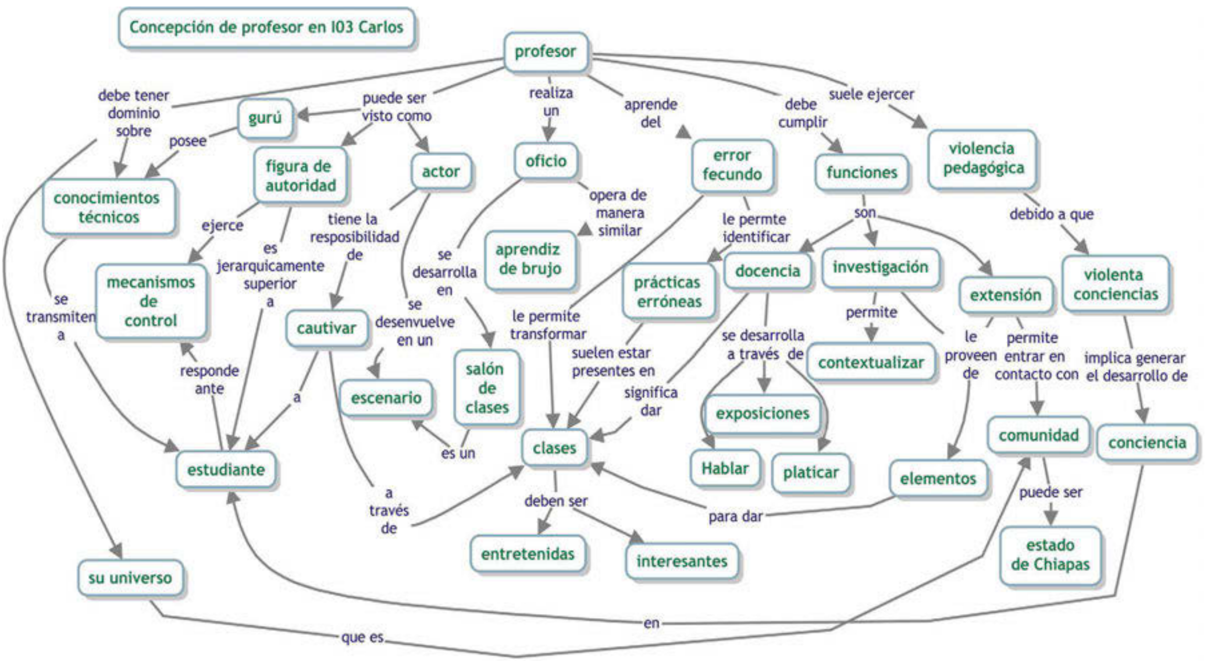
Si bien, el Procedimiento de Mapeo Conceptual para el Análisis Cualitativo en su último momento señala la revisión y comparación constante, Cuenca plantea que este paso es un proceso efectuado por el investigador en cercanía con los datos, sin embargo, poder regresar con los participantes dota de fiabilidad al estudio debido a que permite verificar que el proceso interpretativo durante la construcción de los mapas es cercano a los planteamientos establecidos por el entrevistado y en su caso poder corregir los errores de interpretación del investigador. Además, permite al informante complementar ideas que en su momento no fueron abordadas debido al contexto de la entrevista pero que pueden ser relevantes para el estudio.

El proceso de entrevistas fue realizado de manera presencial, pues el equipo de investigación se trasladó a las ciudades de Tuxtla Gutiérrez y San Cristóbal de las Casas en el estado de Chiapas para realizar el trabajo de campo correspondiente. Sin embargo, la validación se efectuó a distancia. Para la etapa de validación, se utilizó la herramienta Cmap Cloud, tomando en cuenta que los informantes y la investigadora se encontraban en ciudades diferentes. El contacto se estableció vía telefónica y a través de correo electrónico, siendo este último el medio por el que se proporcionaron los enlaces de los mapas conceptuales a cada profesor, quienes tras el análisis proporcionaban sus impresiones, comentarios, observaciones y en caso de ser necesario sugerían nuevas premisas para ser integradas a los mapas.

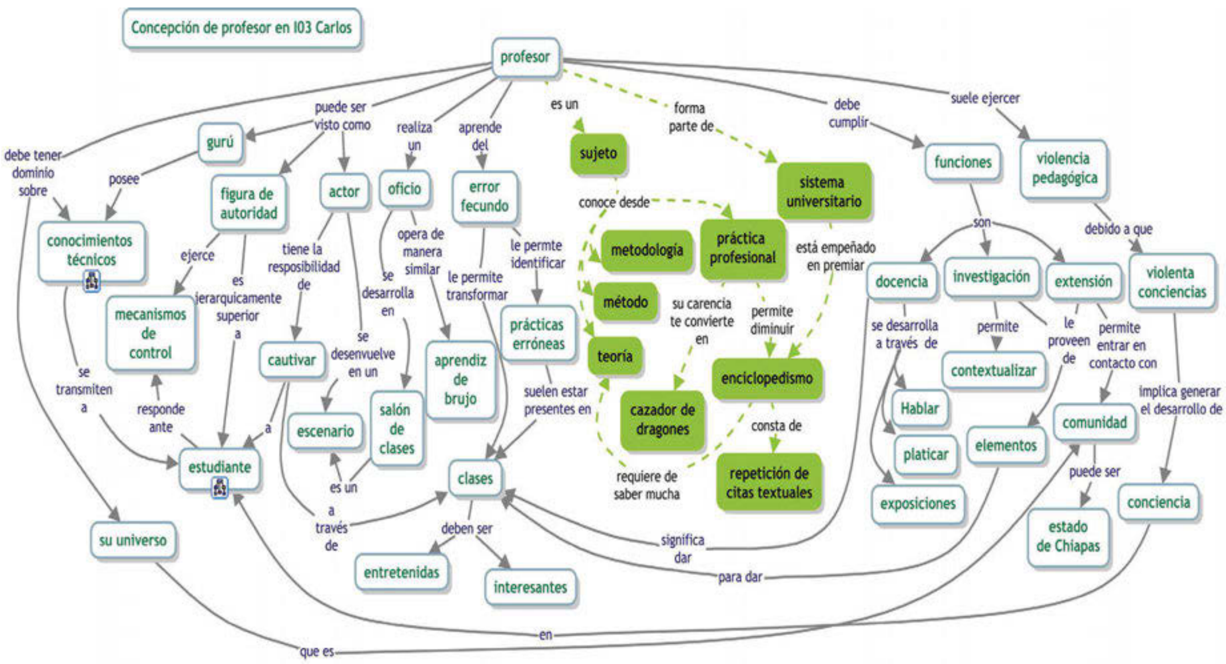
Debe señalarse que los participantes no tenían la opción de editar el mapa directamente debido a que desconocían la herramienta e incluso la técnica del mapeo conceptual, por lo que señalaban de manera escrita aquellas proposiciones con las que estaban en desacuerdo o proponían nuevos enunciados para ser incorporados por la investigadora a los mapas revisados.

Es importante destacar que en ninguno de los casos se obtuvo algún comentario en el que se negara la interpretación de la entrevista por parte de la investigadora y tampoco se solicitó eliminar alguna de las proposiciones. Las retroalimentaciones proporcionadas por los profesores se han limitado a incluir elementos que pueden ayudar a precisar algunos de los conceptos representaos en cada mapa, sin embargo, las premisas siguen permaneciendo inalteradas y el posicionamiento frente a los diferentes planteamientos de la entrevista conserva el mismo sentido.

A continuación, se presentan dos ejemplos de las transformaciones de los mapas conceptuales tras la revisión de los informantes

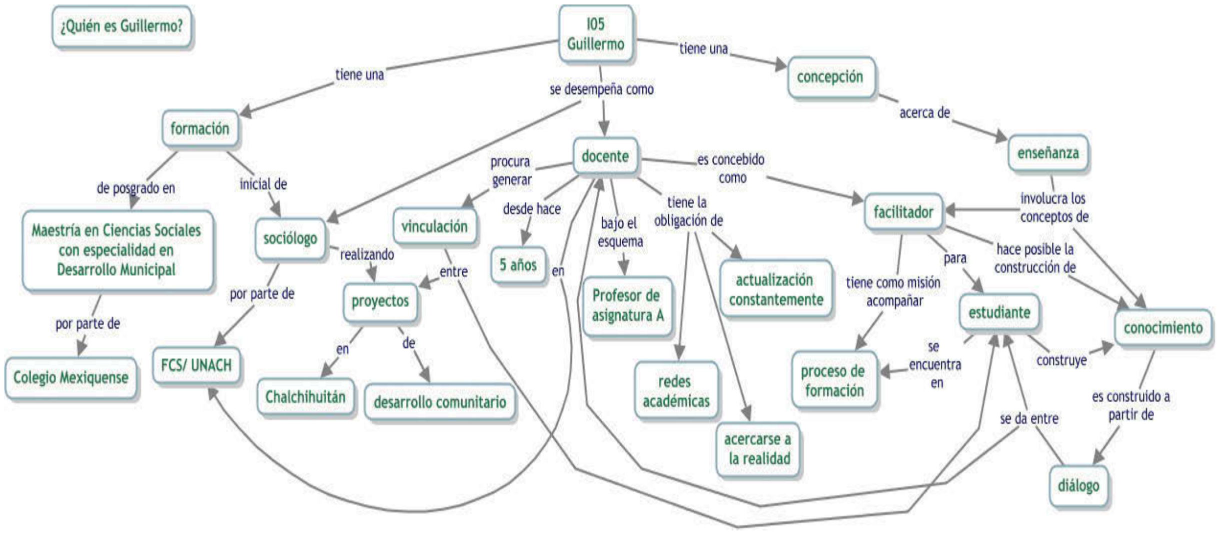


Mapa 2. Concepción de profesor en I03 Carlos, mapa inicial que se desprende de la entrevista realizada en la FCS de la UNACH. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1QC3D7BXF-1WFPC29-4NR.

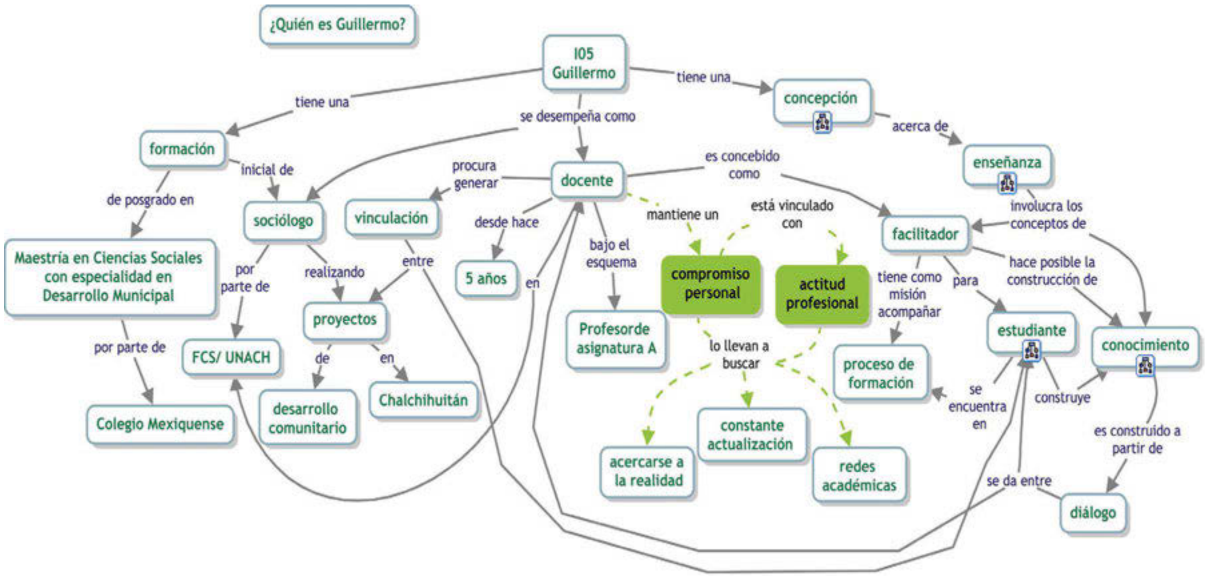


Mapa 3. Concepción de profesor en I03 Carlos, mapa modificado a partir de la retroalimentación proporcionada por el profesor entrevistado, en él se resaltan aquellas proposiciones que fueron integradas tras la revisión del docente. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1QC3D29PH-2DHR282-3X6.

Como es posible observar en los mapas anteriores, la variación radica en la integración de nuevas proposiciones que ayudan a enriquecer la visión sobre cómo se construye el concepto de profesor en Carlos. No se ha solicitado el cambio de otras proposiciones existentes ni el establecimiento de nuevas relaciones entre conceptos presentes en el mapa.



Mapa 4. Mapa de perfil I05 Guillermo, mapa inicial que se desprende de la entrevista realizada en la FCS de la UNACH y describe el perfil del informante. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1QC3D4CL1-Z559KH-4GX.



Mapa 5. Mapa de perfil I05 Guillermo, mapa modificado a partir de los comentarios expresados por el profesor. Se resaltan las proposiciones incorporadas por el profesor una vez analizado el mapa. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1QC3D29PH-8LZN73-3X5.

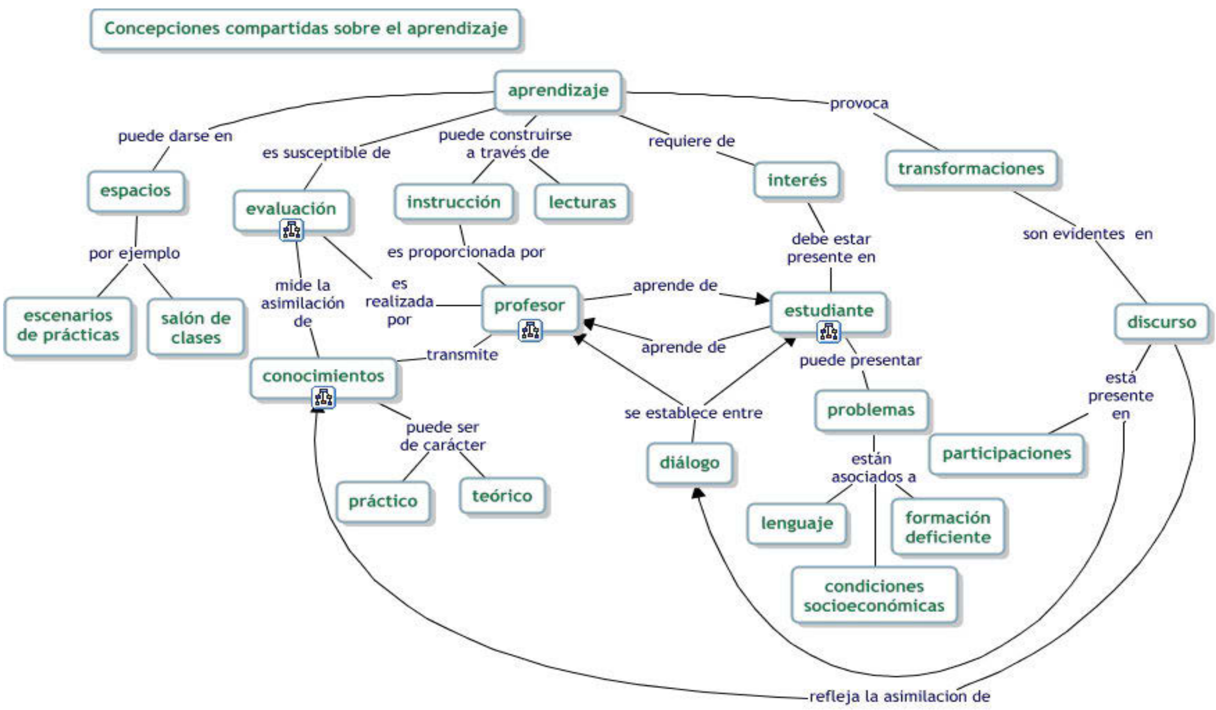
En este otro ejemplo la solicitud del profesor fue la inclusión de los conceptos “compromiso personal” y “actitud profesional” para remarcar la idea de que la obligación de constante actualización no parte de sus responsabilidades ante la universidad sino de la convicción que mantiene de manera personal y profesional. Como es posible apreciar, el resto del mapa se conserva de la misma estructura que el mapa inicial a excepción de algunas modificaciones que se realizaron para efectos de ganar espacio y la incorporación de hipervínculos que permiten la navegación entre el resto de mapas elaborados a partir de la entrevista.

La implementación del MCAC como método de análisis de datos permitió encontrar una serie de concepciones compartidas entre los profesores. Estas concepciones compartidas se acercan o alejan a los nuevos modelos educativos de acuerdo a la temática expresada; por ejemplo, en el caso del concepto de aprendizaje (véase mapa 6) encontramos que es definido por los profesores como un proceso que provoca transformaciones en el pensamiento del estudiante, y éstas transformaciones son evidentes en su lenguaje y discurso que a su vez es reflejo de la asimilación de conocimientos. Sin embargo no hay una relación directa entre estas transformaciones y la evaluación. Por otro lado, los profesores comprenden de manera amplia el concepto de aprendizaje, ya que no atribuyen esta tarea únicamente al estudiante. La capacidad de aprender está presente tanto en maestros como en alumnos y ambos se alimentan en un trabajo simbiótico que está mediado por el diálogo. Aunque remiten el trabajo del docente al de transmitir conocimiento y brindar instrucción.

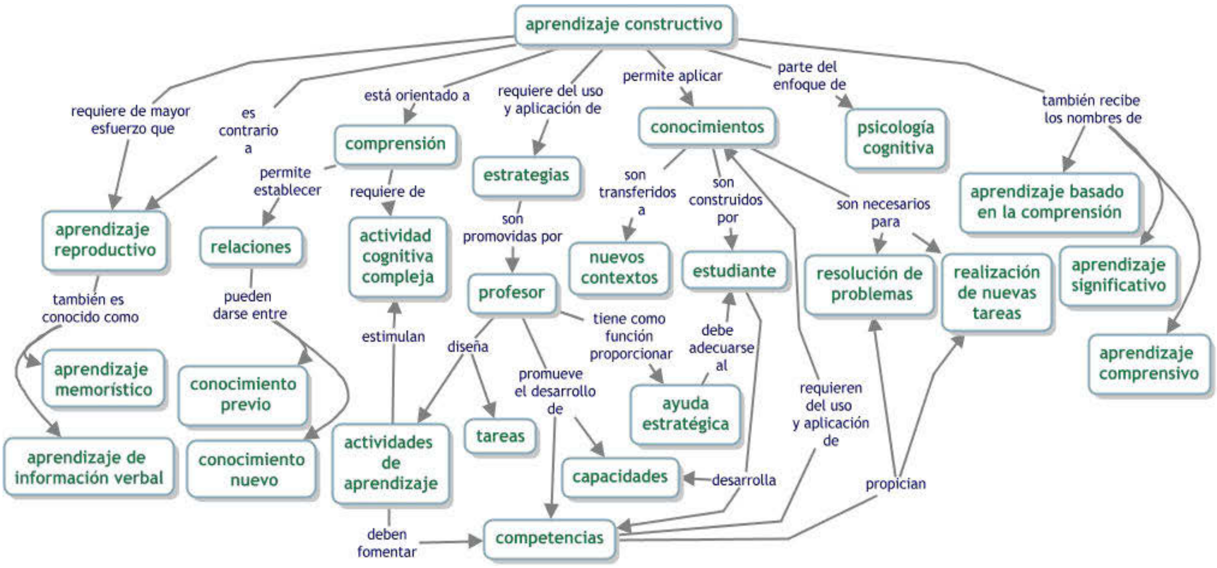
En contraste con propuesta Pozo (2009) (véase mapa 7) el aprendizaje está basado en la comprensión. Permite al estudiante aplicar sus conocimientos en la resolución de problemas y de nuevas tareas así como de realizar su transferencia a nuevos contextos. Por otro lado, el papel del profesor en esta dinámica es la de proporcionar ayudas estratégicas adecuadas al estudiante y diseñar tareas y actividades de aprendizaje que estimulen la actividad cognitiva compleja en el estudiante a fin de favorecer la conexión entre conocimiento previo y nuevo.

Una de las tareas del profesor es diseñar actividades de aprendizaje acordes a las competencias y habilidades que el estudiante debe desarrollar.

Si bien el posicionamiento de los profesores no es del todo cercano a la educación tradicional, podemos encontrar pocos elementos que concuerdan con las propuestas de la *Nueva Cultura Educativa* (Pozo, 2002, 2009, 2014). Estos elementos varían de acuerdo al tipo de conceptos que expresan. Aquellos que están vinculados a sus prácticas evidencian una postura más tradicional, en tanto aquellas concepciones ligadas al pensamiento teórico guardan mayor cercanía a los nuevos modelos.



Mapa 6. Mapa concepciones compartidas sobre el aprendizaje. Disponible para su consulta electrónica en: https://cmapscloud.ihmc.us:443/rid=1QC3FNKPM-CQKGCW-18B.



Mapa 7. Mapa Aprendizaje constructivo, basado en: Pozo & Pérez Echeverría, Aprender para comprender y resolver problemas, 2009, págs. 30-36. Disponible en versión electrónica: https://cmapscloud.ihmc.us:443/rid=1QC3FRDVP-12GV596-1GT.

Aunque la propuesta de Cuenca está basada en un Método de Elicitación de Conocimiento (MEC) e implicó la verificación del producto final, éste no incluye como uno de sus momentos la validación de los mapas resultado del análisis por parte de los expertos. Esta acción es un aporte de esta investigación al MCAC, ya que además de promover la reflexión por parte del informante permite al investigador construir mapas conceptuales que reflejan de manera más precisa el discurso a interpretar.

3 Reflexiones Finales

El ejercicio analítico a través de los Mapas Conceptuales ha permitido encontrar que el posicionamiento del profesor es dicotómico ya que no hay un posicionamiento constante con respecto a teorías tradicionales o a lo Juan Ignacio Pozo llama *La Nueva Cultura de la Educación* (2002, 2009, 2014) de manera tal que de acuerdo al tópico del que se hable, un profesor puede expresar cercanía con una u otra teoría sin ser consciente de la discrepancia entre éstas.

Por ejemplo: cuando se analizan las concepciones de un mismo maestro en torno al concepto autoconcepción docente, las creencias relativas a situaciones operativas son mucho más cercanas a corrientes educativas tradicionales; cuando el docente requiere realizar descripciones de sus funciones como profesor se remite a descripciones ideales que guardan un mayor vínculo con las acciones sugeridas por la literatura que recoge teorías innovadoras en la educación.

Se asume que la situación coyuntural del contexto en el que se desarrollan los profesores alimenta por un lado una visión ideal del rol del docente y de la Universidad; por otro las condiciones de los estudiantes, la tradición y las prácticas operantes en la institución le obligan a continuar con los modelos que ha adoptado. Si bien existen creencias que se oponen de manera directa entre sí, es muy probable que en el ejercicio docente sean evidentes de acuerdo a la situación que el profesor enfrente de manera particular en ese momento.

En cuanto a la propuesta de validación de los Mapas Conceptuales podría considerarse en primera instancia que el desarrollo del proceso analítico de las entrevistas ha sido adecuado debido a las ligeras modificaciones que los participantes han solicitado, aunque también es posible atribuirle este fenómeno a otras situaciones como un análisis poco riguroso de lo expresado por el mapa por parte del validador o incluso la falta de con fianza para realizar una crítica más exhaustiva.

Por otro lado, la incorporación de este momento al modelo MCAC podría permitir a los investigadores dotar de una mayor confiabilidad al estudio debido a que el informante puede confirmar que el conocimiento representado en el mapa responde a su pensamiento y respeta los planteamientos que desea visibilizar. Al mismo tiempo es un ejercicio reflexivo que permite al informante un espacio de metacognición que probablemente no podría darse sin la lectura y análisis de los mapas elaborados por el investigador debido a que los informantes no tienen una cercanía con la técnica del mapa conceptual.

4 Agradecimientos

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A la Universidad Autónoma de Chiapas, particularmente a la Facultad de Ciencias Sociales por las facilidades prestadas para la realización de esta investigación.

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AUTOMATIC CONSTRUCTION OF CONCEPT MAPS FROM TEXTS

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Abstract. The automatic construction of concept maps from texts is still an ongoing research topic, especially when the map should represent, by means of concepts and relationships, a summarization of a complex text. We propose a new method for the automatic generation of concept maps. Based on an analysis of the limitations and best features of the state-of-the-art, this paper introduces a pipeline that comprises (a) grammar rules and depth-first search for the extraction of concepts and links between them from text; (b) anaphora resolution; (c) exploitation of named entities for concept identification; and (d) concept relevance calculation through frequency of occurrence and an analysis of the topology of the concept map. The approach and preliminary results are presented in the form of a prototype, which is still under development.

1 Introduction

According to Novak & Cañas (2008), concepts and relationships form the basis for learning and, therefore, conceptual maps have been extensively used in different situations and for different purposes in education. The standard procedure for building a concept map involves defining a topic or focal question, identifying and listing the most important or "general" concepts related to the topic, ordering the concepts in terms of importance and adding and labeling connecting phrases between concepts. The manual construction of a map requires a significant time and a committed effort in identifying and structuring knowledge, especially when the construction of the map is performed from scratch, that is, when its constituent elements are not predetermined and must be completely identified in some data source. In order to facilitate the process of building concept maps, especially maps in the Novakian style, various technological approaches have been proposed to help automate that process (Richardson & Fox, 2007; Villalon & Calvo, 2011).

The automatic construction of a concept map requires great technological and processing effort. The information extraction techniques must be able to identify concepts that are relevant to a particular domain, identify linking phrases that make the relationship between two concepts significant, define the hierarchy of concepts that will be displayed on the map, and build links between concepts that are not directly evident. Because of these difficulties, many approaches adopt semi-automatic techniques to ensure greater precision in the identification of concepts. In this scenario, we observed (1) the use of predefined list of concepts as the basis for identifying concepts belonging to a particular domain (Clariana & Koul, 2004), (2) the use of ontologies (Graudina & Grundspenkis, 2008) and (3) the use of online documents or concept maps for the extraction of the knowledge related to the domain, in order to assist the process of building or enriching an already available map (Cañas et al., 2004; Valerio & Leake, 2006).

Educational concept maps have been extensively used as learning resources, means of evaluation, instructional organizations, cognitive representations, and for knowledge elicitation and sharing. In addition, concept maps can be used as a summary for large documents (Richardson & Fox, 2007). We are interested in the use of maps in this context, where a complex text can be summarized by a concept map containing only concepts and relationships that represent succinctly what was expressed in a more complex way.

In this paper, we present our prototype based on a new technological approach for the automatic generation of concept maps from scientific texts in English (Aguiar *et al.*, 2015b). The approach will be integrated with a service-based platform, CMPaaS (Cury *et al*., 2014), under development in our laboratory. This platform aims at expanding and integrating basic services such as edition, management, and manipulation of concept maps. These services will be available to anyone in the world. To date, this platform offers services for merging concept maps (Vassoler *et al.*, 2015), information retrieval on maps from questions (Perin *et al.,* 2014), and shallow ontologies construction from maps (Pinotte *et al.,* 2015). In this context, the present study proposes a new service on the CMPaaS platform.

This paper is structured as follows: Section 2 presents some related work; in Section 3 we discuss a new architecture for a *Concept Maps Miner*; Section 4 introduces the process for the automatic construction of concept maps; Section 5 presents the experiments and results obtained so far, with the implementation of a prototype; and finally, Section 6 discusses some preliminary considerations.

2 Related Works

A number of studies have focused on the automatic construction of concept maps, or similar representations, for various applications. However, in this paper, we are interested in approaches related to the construction of maps from documents that adopt the following requirements:

- Approaches that use only one data source, that is, one unstructured text in English. We do not limit the requirement to a specific text size (small, regular or long), although the text size will affect the process and outcome of the approach;
- Approaches which adopt semi or completely automatic extraction techniques;
- Approaches that generate maps in the Novakian style, i.e., we consider those which follow the strict definition established by Novak with regard to adopting a focal question, a hierarchy, labels of concepts and relationships, and establishing links and cross-links among concepts.

The following is a summary and discussion of the related works found in this context. Since the approaches presented aimed at the same objective, which is the automatic extraction of concept maps, what differs is the process carried out for the extraction of text elements and the visual result displayed on the generated map (Figure 1).

Valerio & Lake (2006) introduces the segmentation of web document in topics, the generation of a map for each topic and then the fusion of all maps. Their approach uses morphological and syntactic analysis and relies on the standardization of terms with synonyms and stemming. It identifies noun phrases as concepts (represented as multi-words when applicable) in the parsing tree and applies a statistical analysis for ranking concepts. Triples are defined for each pair of concepts of the tree that has a verbal type dependency. Looking at the map generated by the approach, in Figure 1 (a), we observe: (1) isolated concepts without relationships; (2) map portions fragmented for each sentence; (3) a lack of anaphora resolution; and (4) Propositions with only a direct link in the sentence.

Richardson & Fox (2007) show the generation of maps for a dissertation, containing only the chapters or the overall information of each chapter. Their approach combines morphological and syntactic analysis, anaphora resolution and entity recognition for building semantic primitives with the help of an ontology. Looking at the map generated by the approach, in Figure 1 (b), we observe that the concepts do not seem to represent the relevant information contained in the chapter of a dissertation, therefore preventing a full analysis.

Wang et al. (2008) generate maps from text abstracts. This approach uses morphological and syntactic analysis, identifying the elements based on the structure of the phrases and syntactic rules. It applies normalization to correct orthographic mistakes, and relies on synonyms detection and anaphora resolution. It uses statistical analysis to check the relevance of the propositions. Uncertain propositions are defined by means of user interaction through questions. Looking at the map generated by the approach, in Figure 1 (c), we observe: (1) map is fragmented in portions; (2) the approach assigns very long labels to concepts; (3) it accepts pronouns as labels for concepts; (4) it accepts prepositions as labels for relationships.

Villalon & Calvo (2011) use linguistic techniques to generate maps for descriptive texts made by students. Their approach creates a dependency parse tree which is transformed into a terminological map. The concepts are extracted from the vertices and the relationships based on the shortest path between two concepts. It applies a set of semantic rules for the terminological map reduction. Besides, it performs a statistical analysis for the computation of terms' relevance. Analyzing the map generated by the approach, in Figure 1 (d), we observe that (1) the map is fragmented in portions and (2) it accepts prepositions as label for the relationships.

Qasim et al. (2013) uses language dependencies to generate maps for scientific articles. It explores the graph of dependencies to extract concepts and relationships (e.g. hyponyms) based on the type of dependencies in the graph. It performs a statistical analysis for the identification of terms' relevance. It uses similarity metrics and clustering to group concepts based on their relationships. Triples are defined if the concepts belong to the same sentence and if the terms found are of the form <subject-verb-object>. Analyzing the map generated by the approach, in Figure 1 (e), we observe that the labels of relationships are defined by the assigned type of dependence. The displayed map is generated from a single sentence.

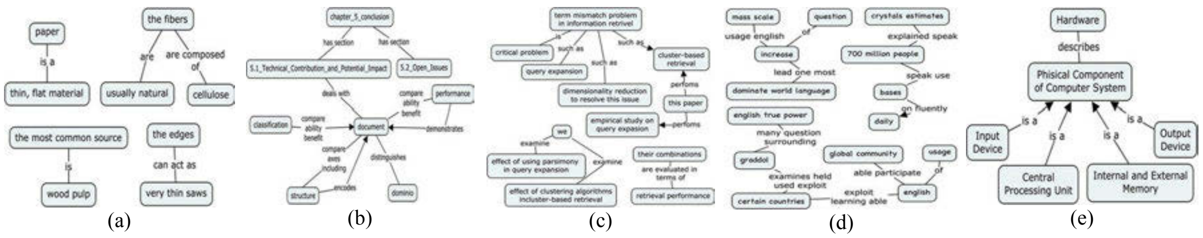


Figure 1. Maps generated by the approaches discussed in Section 2.

According to the analysis carried out on the approaches, we can identify the following challenges: (1) a difficulty in defining small and meaningful labels; (2) A challenge for the identification of relevant concepts related to a given domain; (3) Difficulties for establishing links between concepts which are not directly evidenced in the text; and (4) The complexity of the identification of the domain of a document.

3 A Proposal for a Concept Map Miner (CMM)

A Concept Map Miner is defined as a process for the automatic extraction of concept maps from documents targeted to the educational context (Villalón & Calvo, 2011). This can be formalized by defining a document D as a set D = {Cd, Rd}, where Cd is the set of all concepts, and Rd the set of all links extracted from the document. This extraction process may be synthesized in the following steps: Concept Identification, Relationship Identification and Summarization. The result is a concept map CM = {C, R, T}, where CM is defined by the set of concepts C, relationships R and a topological organization T, as shown in Figure 2 (a).

Using a different perspective from the one by Villalón & Calvo (2011), we propose a process for building maps covering four axes of interest: the *Data Source Description* step defines the techniques used in the information extraction process as well as the appropriate manipulation methods such as the linguistic, statistical, and machine learning techniques, the element retrieval and identification (detailed in Aguiar *et al*., 2016a); the *Domain Definition* step identifies the relevant concepts of the domain; the *Elements Identification* step can be regarded as the core of the process, which makes use of the earlier steps to extract concepts and relationships; and the *Map Visualization* step specifies the graphic positioning of propositions in the concept map, since maps are graphical tools and knowledge visualization is part of the learning process. Such axes should be understood as the steps for the automatic extraction of concept maps from texts (Aguiar *et al*, 2015b).

The proposed process is presented in Figure 2. Figure 2 (b) starts by the description of the data source to characterize a document *D*.

A document *D* of size *n* can be defined as

$D = \{d_1 \ldots d_n\}$ where

d_i, , i=1…, n is a term in D.

A set of concepts can be defined as

$C = \{c_1 \ldots c_n\}$ where

$C \subseteq D$

and

c_i, is a term d_i that represents a concept or entity for the domain.

A set of relationships can be defined as

$R = \{r_1 \ldots r_n\}$ where

$R \subseteq D$

and

r_i is a set of concatenated terms d1,_..._d_i that represent a relation between concepts.

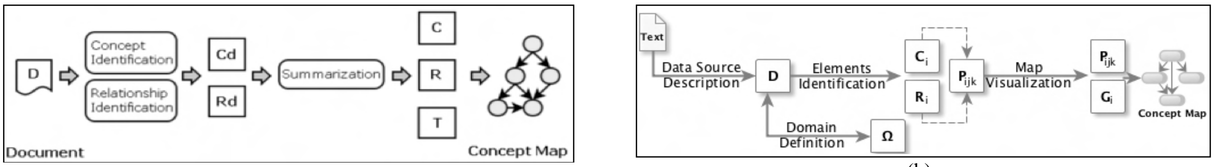
The document *D* is used as an input to the Domain Definition step for the discovery of the document domain Ω. The domain Ω is the union of concepts *C* extracted from a document *D*.

A proposition can be defined as

$P_{ijk} = \{c_i, r_j, c_k\}$ where

$c_i \in C$ and $c_k \in C$ and $r_j \in R$.

During the Map Visualization step, for each proposition P_{ijk}, we assign a graphical position G_i to form a set of propositions organized topologically in the concept map defined as $CM = \{P_{ijk}, G_i\}$.



(a) (b)

Figure 2. The Process of the Concept Map Miner.

The description of the data source impacts the whole process of building the conceptual map. In this context, we identified several variations in the approaches used for the extraction of concept maps in terms of size and quantity of information available in the data source. (1) For the size, we can characterize unstructured data sources as (a) small: small content such as abstracts; (b) regular: few data pages such as academic articles, reports, newspaper, articles etc.; (c) long: extensive data containing a lot of information such as theses and dissertations. (2) According to size dimension, the data source may be represented in two groups: (a) approaches that use a set of documents to represent the knowledge of a domain and (b) approaches that use a single document that represents the knowledge specific to one author.

We believe that one of the challenges for the automatic construction of concept maps from texts is the definition of the domain, i.e. of the text domain or the concepts belonging to the domain. In this scenario, we note the use of semi-automatic techniques where the author identifies the domain of the data source by (1) choosing a suitable ontology (Graudina & Grundspenkis, 2008), or (2) using multiple maps (Valerio et al., 2008), or (3) using a list of concepts (Clariana & Koul, 2004) or (4) by means of a set of documents (Lau et al., 2008).

The identification of the elements, defined as the core of the process, is to extract propositions i.e., *concept-relationship-concept* triples, which will compose the concept map. For a map to be representative, the information must be relevant to the domain, be properly labeled and significantly connected. We have observed approaches that generate fragmented maps with disconnected concepts (Villalón & Calvo, 2011; Valerio *et al*, 2008), or that attribute incomplete or extensive labels (Wang *et al*., 2008), or approaches that fail to create relationships between some concepts (Valerio *et al*, 2008; Villalón & Calvo, 2011), and that do not identify the available linking phrases (Clariana & Koul, 2004).

The map visualization shows the topological structure of propositions identified in the Identification Elements step by means of a graphical interface. In this case, we observed that many approaches are not focused on the map view. Instead, they use third-party tools for these purposes (Villalón & Calvo, 2011; Clariana & Koul, 2004). However, some approaches develop their own display interface including features that facilitate learning, such as (1) a list of occurrences of the concept within the context (Zouaq *et al*., 2007), (2) a partial map view from the perspective of a concept (Lau *et al*., 2008) or (3) the display of the path of a specific concept until the focus question (Kumazawa, 2009).

We believe that the steps proposed by Villalón & Calvo (2011) are embedded in the last two steps of our process, which also follow the three principles of educational utility, simplicity, and subjectivity in the automatic construction of concept maps.

4 On the Approach

Our approach began with the categorization we defined in Aguiar *et al*. (2015a) which, together with the CMM process (Section 3) were used for the development of the approach presented in this paper. The approach is still under implementation as a Web service in Java in conjunction with the framework Spring. The following sections detail each step of the process.

4.1 Description of Data Source

With respect to the Data Source Description step, our approach is characterized by the use of unstructured text in English, in the forms of academic articles whose size is classified as regular according to our definition in Section 3. Being an academic text, the language is formal and the text quality is ensured by its publication. The data source is limited to a single document, since the goal is the representation of the knowledge extracted from text as a summary. The data source is chosen by the User and used as input to the whole process.

4.2 Definition of the Domain

With respect to the Domain Definition step, our approach is characterized by relying on a human User, who initially chooses the data source in step 4.1, to assist the process of domain identification. For the semi automatic Domain Identification of a given text, our approach proposes the use of supervised learning techniques of clustering and classification but this is left for future work. For the identification of the elements belonging to a particular domain, we propose the use of an automatically-built domain thesaurus at this stage. The thesaurus is represents a conceptual vocabulary for a given domain and is built incrementally as new texts from the same domain are processed to build concept maps.

4.3 Identification of the Elements

For the Identification of Elements (concepts, linking phrases) we defined the following rules: (1) labels in concepts are formed by nouns and linking phrases contain a verb; (2) the generated propositions should represent the information contained in the data source; (3) the generated propositions must belong to the identified domain; (4) propositions belonging to the same domain should be connected by linking phrases.

The process for the identification of the elements, shown in Figure 3, is divided into 12 steps, starting from the Preparation step with the reception of the data source, and ending at the Ranking and Summarization step with the construction of propositions of the form *concept-relationship-concept*. Most of these steps are implemented using Stanford CoreNLP (Manning *at al.*, 2014), a set of tools for analyzing natural language provided by Stanford University, together with algorithms developed in our approach.

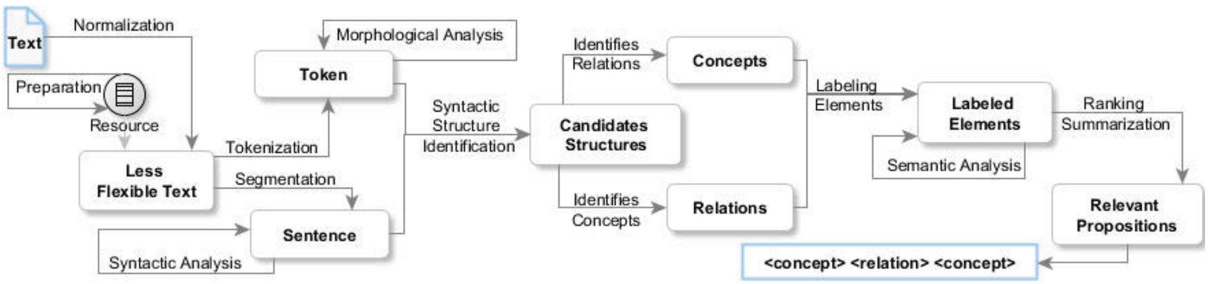


Figure 3. Process adopted by our approach.

The **Preparation** step is responsible for providing all the resources needed for performing the extraction process. In this case it includes the manual mapping of prepositions with a predefined linking phrase including the preposition. For example, the preposition “between” is mapped to “appear between”. This step is performed only once.

The **Normalization** step modifies the data source to ease further processing. This comprises (a) eliminating label markers, tags and font style; (b) removing special characters; (c) solving genitive forms by converting possessive case to a normal form; (d) removing non-propositional sentences; and (e) resolving anaphora. Stop words are not removed in this step, since their removal negatively influences the later processes.

The Steps for **Tokenization** and **Morphological Analysis** are performed in parallel, focusing on individual terms. The first step divides the text into tokens; the second identifies the part of speech of each identified token. We use the tokens that contain the tag (a) Noun (NN) and its related Plural Noun (NNS), Singular Proper Noun (NNP) and Plural Proper Noun (NNPS); (b) Adjective (JJ); (c) Cardinal Number (CD); (d)Verb (VB) and its derived Past Tense Verb (VBD), Gerund or Present Participle Verb (VBG), Past Participle Verb (VBN), Non-3rd Person Singular Present Verb (VBP), 3rd Person Singular Present Verb (VBZ) and Modal (MD); (e) Determinant (DT); (f) Adverb (RB) and (g)Preposition (IN) and its derived To (TO). Related tags and optional tags are represented in the article by their first tag followed by apostrophe and by the symbol *, respectively. For example, if we want to represent the tag NN and all its related tags, we use NN’, or if it is optional we use NN*.

The **Text Segmentation** and **Syntactic Analysis** steps are performed in parallel, focusing on sentences. The first step provides the segmentation of plain text into individual sentences; the second analyses these sentences to build the sentence parse tree. For this we use two types of grammatical analysis: Clause Level Syntagms, representing simple declarative sentences (S) and Phrase Level Syntagms, containing nominal phrases (NP), verbal phrases (VP) and prepositional phrases (PP). Syntagms not included in these rules are removed from the parsing tree.

The **Syntactic Structure Identification** step applies a new segmentation to the parsing tree of each sentence to identify the candidate structures for a proposition. Namely, all the candidate structures which are occurrences of the following pattern (NP (JJ*)(NN')) ({VP (VB') | PP (IN')} (RB'*) (NP (JJ*)(NN'))) are extracted. We use a depth-first search to look for this syntactic pattern, regardless of the intermediate structures between the syntagms. The pattern will be matched only if the syntagms are completely identified, i.e. we define a complete (a) NP syntagm when it contains a core NN or one of its derivatives, (b) VP syntagm when it contains a core VB or one of its derivatives and a complete NP syntagm, (c) PP syntagm when it contains a core IN or a derivative and a complete NP syntagm.

Complete NPs and VPs syntagms are extracted by finding their sub-trees. For searching the occurrences of a pattern, we adopted three general ideas: (a) searching simple declarative syntagms, (b) searching nominal syntagms and (c) searching preposition syntagms.

During the **Concepts** and **Relationships Identification** step, morphological rules are applied to the candidate structures to identify concepts and relationship. For this, we use the following rules: (1) if the candidate structure is composed by a NP syntagm and its nucleus belongs to {JJ, NN', CD}, then a Concept is identified; (2) if the candidate structure is composed by a VP syntagm and its nucleus belongs to {VB', IN', RB}, then a Relationship is identified; (3) if there is a relationship of specialization between two concepts, then the label "is type of" is assigned.

The steps **Labeling Elements** and **Semantic Analysis** are executed together to reduce the ambiguity and improve the labeling of the extracted elements (concepts and relationship). For this, we used the following rules: (a) multi-words are identified by applying grammar rules on the extracted syntagms; (b) similar concepts are assigned a unique label. We use similarity measure LIN (Lin, 1998) to calculate the similarity of two lemmatized concepts through the dictionary lexicon Wordnet (George, 1995). For example, the concept "ability" and "creative_thinking" is considered similar with 0.85 score; (c) prepositions are transformed into preposition phrases according to the mapping defined in the Preparation step; (d) named entities (places, organizations and proper names) are not directly extracted, since we understand that they are instances of classes (concepts) and should not be represented on the map. However, identifying their types can be of interest to our concept map. To this end, named entity detection is performed using Stanford NER[1] and each sentence of the data source that contains it is retained in a textual summary. A query containing the entity label and the entity type is executed on DBPedia. For example, for the concept "David Ausubel" a query is created with rdf:type dbo:Person and foaf:name "David Ausubel". The abstract result of DBPedia is stored as a vector and compared with the vector representation of the extracted summary through cosine similarity. If the similarity is high, the description is assigned as concept; otherwise, the entity type is assigned. An example of a SPARQL query is shown below where variable "*var*" is replaced by a concept, for example "David Ausubel".

```
SELECT DISTINCT ?node ?name ?abstract ?descriptionDc ?shortDescription
WHERE { ?node rdf:type dbo:Person .
        ?node foaf:name ?name. FILTER langMatches(lang(?name),'en').
        ?node dbo:abstract ?abstract. FILTER langMatches(lang(?abstract),'en').
OPTIONAL {?node dbp:shortDescription ?shortDescription. }.
OPTIONAL {?node dc:description ?descriptionDc. }.
FILTER (regex(lcase(str(?name)), \"^"+var+"\") || regex(lcase(str(?name)), \""+var+"$\") || regex(lcase(str(?name)), \" "+var+" \"))}
```

The **Ranking** and **Summarization** step is responsible for defining the most relevant elements to the domain. For this, we represent the list of propositions in the form of a graph and make use of the HARD model (Leake *et al.*, 2004), computing the weight W of each concept k, using the formula:

$$W(k) \equiv \left[\sigma \cdot TF_d(k)\right] + \left[\rho \cdot \left(\alpha \cdot a(k) + \beta \cdot h(k)\right)\right]$$

In the formula, TF_d is the frequency of the concept in the list of identified concepts in the document, a is the weight of the authoritative nodes (concepts with multiple incoming links), h is the weight of the hub nodes (concepts with multiple output links). The parameters assigned for $\alpha = 1.764$ and $\beta = 2.235$ were found in the best adjustment made by Leake *et al.* (2004) and the parameters $\sigma = 0.6$ and $\varrho = 0.2$ were adopted in the experiment step.

1

Stanford NER is a Java implementation of a Named Entity Recognizer. NER labels sequences of words in a text which are the names of things in the classes, such as Person, Organization and Location.

4.4 *Map Visualization*

The approach is characterized by the development of a proper interface for viewing the generated concept map. It includes features to display the hierarchy of concepts and to identify sub-concepts (Ausubel, 1968). Since the approach aims at automatically building concept maps from texts, most often unknown by the student, we believe that the identification of those concepts is essential for an easier understanding and assimilation of knowledge.

5 Experiments and Results

This section presents a first prototype of the approach. To perform the experiments, we use the Introduction section of the article published by Novak & Cañas (2008) as the data source. The text is written in English and is composed of 26 sentences and 617 words. Our evaluation focuses on the Element Identification step, since the approach is still being developed. Two experiments were conducted: (1) the generation of concept map containing all identified propositions extracted from the data source and (2) the generation of concept maps containing propositions filtered by the Ranking and Summarization step.

5.1 *First Experiment*

The first experiment identified 26 sentences, 141 propositions and 81 concepts. Figure 4, illustrates the output of this process without applying the Ranking and Summarization step, i.e., it shows all propositions extracted from the data source. A concept map constructed with CmapTools represents the process output.

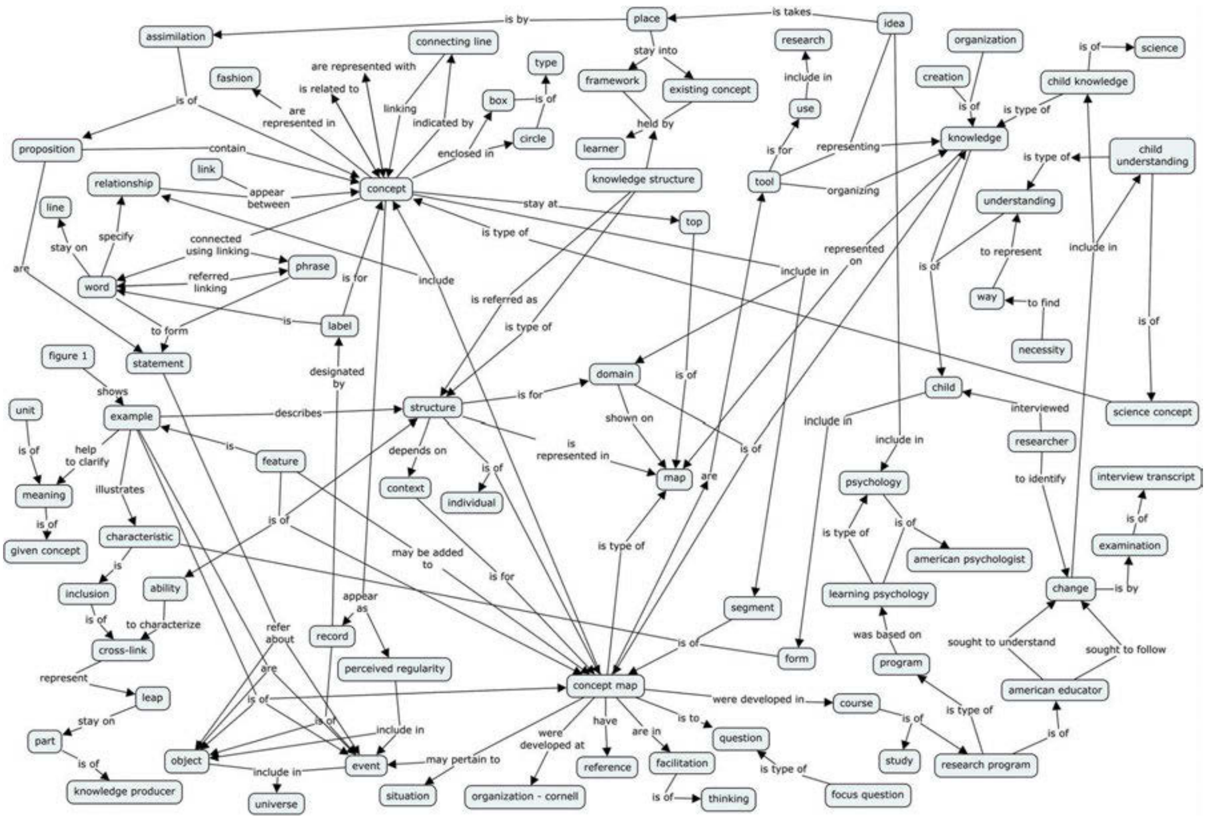


Figure 4. Extracted concept map in the first experiment.

Here, we highlight some of the features of the concept map generated by our service in the first experiment (see Figure 4 and Section 4.3):

- Proposition identification from a prepositional sentence - The proposition <*relationship*> <*appear between*> <*concept*> is extracted from the text "These are relationships or links between concepts in different segments...". The approach creates a relationship between the concepts "relationship" and "concept" with the label "appear between". The labels are defined with the help of the prepositions mapping carried out during the Preparation step.

- Proposition identification from implicit relationships - The concept "program" is extracted from the text "This program was based on the learning psychology...", and the concept "research program" is extracted from the text "…course of Novak's research program at Cornell...". The approach has created a specialization relationship between the concept "program" and "research program", with the label "is type of".
- Anaphora resolution - The proposition *<concept map>* *<include>* *<concept>* was extracted from the text "Concept maps are graphical tools for organizing and representing knowledge. They include concepts...". The approach associates the pronoun "they" to the concept "concept map". The approach ignores the personal pronouns of the first person, since we observe that they do not contribute significantly to the understanding of the map. Thus, the proposition *<we>* *<define>* *<concept>* extracted from the text "We define concept as a perceived regularity..." is not represented on the map. Handling demonstrative pronouns is left for future work.
- Proposition identification from distant syntactic connections - Using the syntax tree created for the text "Figure 1 shows an example of a concept map that describes the structure of concept maps and illustrates the above characteristics.", the approach extract the distant propositions: *<figure 1>* *<shows>* *<example>*, *<example>* *<describes>* *<structure>*, *<example>* *<illustrates>* *<characteristic>*, *<example>* *<is of>* *<concept map>*, *<structure>* *<is of>* *<concept map>*.
- Similarity of concepts - The concept "Ausubel", extracted from the text "The fundamental idea in Ausubel's cognitive psychology...", and the concept "David Ausubel", extracted from "This program was based on the learning psychology of David Ausubel...", are considered as similar concepts and are represented by the most significant label, "David Ausubel". The concepts "concept" and "concepts" are associated as similar concepts and represented by the label "concept". Our approach favors the most generic or high-level labels when there are concepts with some proximity, and more specific labels otherwise. That is, the concept "good map" is represented by the more general concept "map" and the concept "interview transcript" remains with its original label.
- Labeling of entities - Concepts defined as entities of type Person are associated with their description found on DBPedia. For instance, the concept "David Ausubel" is associated with the URI "American psychologist" on DBpedia.
- Identification of multi-words concepts - The approach adopts lexical and syntactic rules to identify more complete labels of concepts, such as "knowledge producer".
- Conversion of genitive form into a normal form "is of" - The proposition *<research program>* *<is of>* *<american educator>* is extracted from "… course of Novak's research program at Cornell...". The approach identifies and transforms the genitive form into a normal form.

5.2 Second Experiment

The second experiment added the Ranking and Summarization step to the process undertaken in the previous experiment, i.e., it applied the full process proposed by our service. The experiment used 10% of the ranking for the Summarization step, identifying 8 relevant concepts and 75 related propositions. Figure 5 illustrates the output of this process.

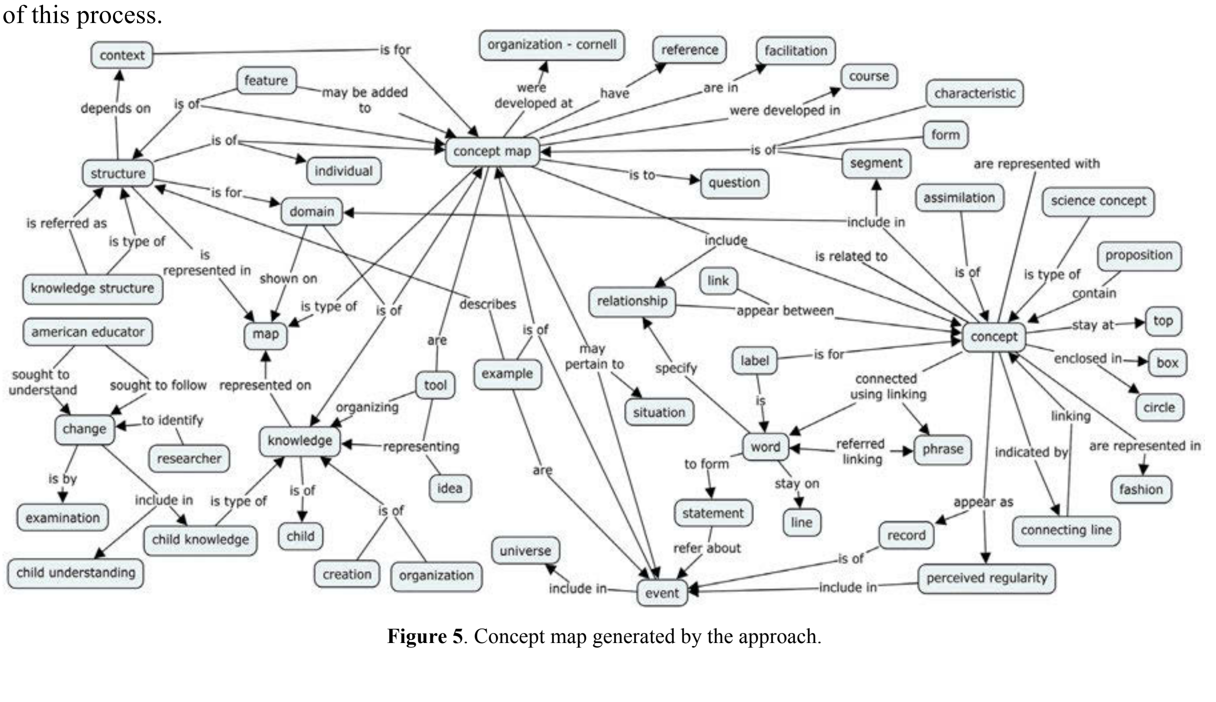


Figure 5. Concept map generated by the approach.

The experimental analysis, to date, was conducted subjectively by comparing the map built by our approach shown in Figure 5, with others from related works, applied on the same example text. Our intention is to analyze the visual quality of the map generated and the fidelity of the tool with respect to the original text.

For the visual quality, we note some strong points associated to the map built by our prototype which outperformed the results reported by related works, namely: (1) all the concepts are connected by linking phrases without fragments. Despite the Summarization step, the resulting concept map establishes relationships between concepts, even for distant concepts. (2) labels are directly extracted from the data source. (3) Neither pronouns nor named entities make up relevant concept labels. (4) Concept labels are small, meaningful, formed by multi-words expressions when applicable; (5) relationship labels are meaningful and formed by verbs; (6) relationship between concepts are sometimes not explicitly mentioned in the text; (7) concepts and propositions do not exhibit any redundancy; (8) the map faithfully represents the textual information.

In order to analyze the generated map fidelity to the text, we compared the automatically generated concept map to concept maps manually built by ten domain experts. The following instructions were provided: (1) the experts received information about the use of concept maps in general and about the purpose of the experiment; (2) they were instructed that the label of concepts and relationships should be short, meaningful and extracted from the text; (3) they were informed that concepts' labels should contain nouns, and relations' labels should contain verbs; (4) they were instructed that labels containing named entities or prepositions should be changed to more appropriate labels.

The following tables show the precision and recall calculated by comparing the map constructed by the approach with the maps generated by the experts. Table 1 shows the analysis of the identified concepts, reaching 0.47 in Precision and 0.67 in Recall. In this experiment, we disregarded the label flexion of concept maps built by experts, such as grammatical gender, number and degree.

Concept Analysis											
Expert	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.8	Exp.9	Exp.10	**AVG**
Precision	0.60	0.42	0.44	0.56	0.52	0.48	0.46	0.38	0.42	0.42	**0.47**
Recall	0.58	0.72	0.69	0.74	0.59	0.67	0.61	0.73	0.60	0.78	**0.67**

Table 1: Results for fidelity of Concepts.

Table 2 shows the analysis of the identified relationships, obtaining 0.29 in Precision and 0.44 in Recall. In this evaluation, we consider relations as similar to those generated by the experts if they are linking the same concepts exactly and their meaning is similar. This represents a limitation of our evaluation and should be further completed by an evaluation of relations' labels in future work.

Relationship Analysis											
Expert	Exp.1	Exp.2	Exp.3	Exp.4	Exp.5	Exp.6	Exp.7	Exp.8	Exp.9	Exp.10	**AVG**
Precision	0.37	0.24	0.23	0.33	0.31	0.35	0.23	0.23	0.29	0.28	**0.29**
Recall	0.41	0.47	0.50	0.38	0.37	0.48	0.33	0.53	0.45	0.51	**0.44**

Table 2: Results for fidelity of Relationships.

From the experiment, we note that building a map from of text is a difficult task, even for domain experts. In fact, the experts were told to not represent the concepts in their cognitive structure. Instead, they were instructed to use only the concepts expressed in the text, which they found difficult.

The results obtained in Table 1 and Table 2 are modest mainly because of the complexity of the task but also because our approach does not have an extended capability for domain identification. We believe that this issue should be alleviated by the use of a domain thesaurus. This thesaurus will be gradually constructed as new domain texts are processed. Nevertheless, we still have other challenges that can be summarized as follows:

- The anaphora resolution is still far from satisfactory, especially with respect to demonstrative pronouns, possessive pronouns and personal pronouns of the first person.
- Some assigned labels do not correspond to the labels assigned by the experts. The service, sometimes, did not make use of some adjectives and adverbs relatively important for characterizing the labels.

- Some relationships assigned by the experts were not explicitly extracted from the text because the pre-existing information in their cognitive structure interfered in their representation of the map. Thus it was not possible to directly compare them to our extracted relations.
- Some relevant domain concepts were lost during the second experiment due to our ranking.

6 Discussion and Further Work

The development of technological approaches for the automatic construction of concept maps from texts has shown promising results, although they are not yet satisfactorily resolved. In order to contribute to efforts aimed at overcoming this challenge, we present a new approach composed mainly of two elements: (1) the CMM process, which represents an extension of the version proposed by Vilallón & Calvo (2011); (2) the definition of an approach for the automatic construction of concept maps.

The approach presented in this paper stands out by the implemented grammar patterns and the use of depth-first search for the identification of concept maps' elements. Our approach relies on anaphora resolution, genitive form conversion, prepositions mapping and the identification of the type of named entities on DBpedia. For the relevance of concepts, the approach also presents a method combining the frequency of elements with the topology of the map. In general, we can state that, so far, our experiments have shown that the approach yielded acceptable results, both quantitative and qualitative, for the identification of the constituent elements of a concept map.

In our future work, we plan: (1) to enhance our anaphora resolution process; (2) to expand the classes of recognized entities and concepts based on Semantic Web knowledge bases, ensuring more appropriate concepts labeling; (3) to better identify relationships of specialization, generalization and hyponyms, allowing to establish relationships beyond the syntactic level; (4) to experiment with other ranking and scoring strategies for concept relevance. We also plan to use our prototype in a course on concept maps that will be offered to high school teachers of the public network of our state in Brazil. We count on this course to test our service in real-world settings and expect that suggestions for modifications and improvements will emerge once the course is started.

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BOTTOM-UP CONCEPT MAPS SUPPORTING GENERALIZATION

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Abstract. A preliminary study is critically reported to evaluate the feasibility of using concept mapping as an additional, flexible resource to strengthen the construction of superordinate concepts in a constructivist and mediative environment. One class of 24 fifteen-year-old students of the II-year chemistry course has been involved in a six-month study, divided into two phases.

1 Introduction

This paper reports a series of strategic actions aimed to develop - in a single class of food science and chemistry with 24 fifteen-year-old students (2nd year of Italian secondary school) - the mastery of superordinate concepts and to focus the attention on how these concepts can be applied, connected and developed to form dynamically connected systems. The specific class was chosen among the other possible candidates of same year because of its positive acceptance of educative relationship, absence of conflicts and vivacity of its atmosphere, likewise forecasting of intellectual vivacity. The second year, for studying the processes of conceptual change, was deliberately chosen by the author to proximally extend his previous research about conceptual development for 16 & 17 year olds (third and fourth year) (Tifi. 2014), whose finely tuned strategies were seemingly inapplicable with younger students of the first two years. The study was conducted starting in November 2015, after one month of training in concept mapping (Table 1).

2 Capturing the Synthesis of a Lesson

The initial aim of this action-research, was to compare the students' gain in drawing concept maps, versus writing short texts, as two alternative tools to facilitate the synthesis of any new topic that was introduced in the class. A few minutes after the topic was interactively presented, the students were answering a specific and overarching *focus question* in the two alternative modalities. During the answering phase, both the concept-mapper and text-writer students could view the same short list of relevant concepts and the same focus question on the whiteboard, as a guide to elaborate their personal synthetic answer, after it had been discussed, agreed and sometimes written. They were given around 10-15 minutes to arrange the text or the concept map. Depending on the lesson-time remaining, one or two of the elaborated documents were discussed and given more individual feedback, or used as stimuli for giving a feedback to the whole class.

Focus Question: How do substances in food undergo transformations in the nutrition process?
*"Nutrient substances are frequently transformed to perform their functions (**energetic**, **bioregulatory**, **plastic**). In carrying out the plastic function they become more complex, whereas in the **energetic catabolism** the substances become simpler. In a few cases, the food principles remain unchanged, just aggregating themselves with other substances" (S.F. October 19th)*

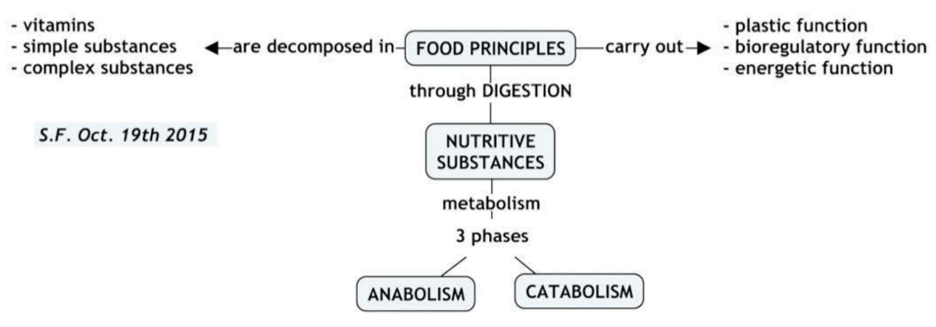

Figure 1. First synthesis, with both text and cmap, by S.F. Focus question: "How do substances in food undergo transformations in the nutrition process?" The cmap reports errors and concepts in linking phrases, while the text-answer was excellent.

The first activities, in October-November 2015 were initially exploited as for the necessary *training* in concept mapping, by following simple rules, often disregarded (as in Fig. 1), because the use of paper and pencil facilitated "free style" scheme construction, while the lack of online sharing slowed down the revision process.

RULES FOR CONSTRUCTING CONCEPT MAPS
1) concept words must be placed into boxes, whereas the linking words must be written into the connecting lines
2) Every connected triplet: [CONCEPT-1] ─ *linking words*→[CONCEPT-2], should result in a complete and meaningful phrase
3) Most important concepts ought to be placed upward and the subordinate ones downward, forming a “Christmas tree” shape
4) Concepts mustn’t be repeated in the concept map

Table 1: Rules of concept mapping

To grasp the context of these activities, it is important to know that the focus question was given to the students in advance; then, during the interactive lesson, the emerging concepts were gathered, sometimes hierarchically organized, and then partial conclusions were negotiated, “dictated” from students, and then recorded on the whiteboard. However, during the synthesis phase, students could only view the concept labels and the focus question. This strategy was deliberately designed to train or make learners’ *short term memory* more flexible, because the modality and quantity of access to it change considerably from the highly scaffolded interactive discussion to the individual task with reduced guidance. In the first phase, thinking is dominated by external language, whereas in the individual phase *internal language* is more solicited. So we can hazard that - as far as processes of reflection and voluntary access to short - and long - term memory are entailed, it is in this second phase that the learner is operating more consciously within their zone of proximal development, whereas during public debate or lecture, working memory is overloaded.

The following text and concept maps, attempting to answer the same focus question, can help us to understand what could happen with students endowed with different zones of proximal development.

Focus question (Nov. 7th 2015): “*Are there connections between the two ways of classifying food?*”

M.V.: “The nutritional characteristics of food groups are not entirely independent of food’s origins, one example being that protein-rich foods are distinct into two different groups, one of protein-rich food originated from animals, the second formed by protein-rich plants.”

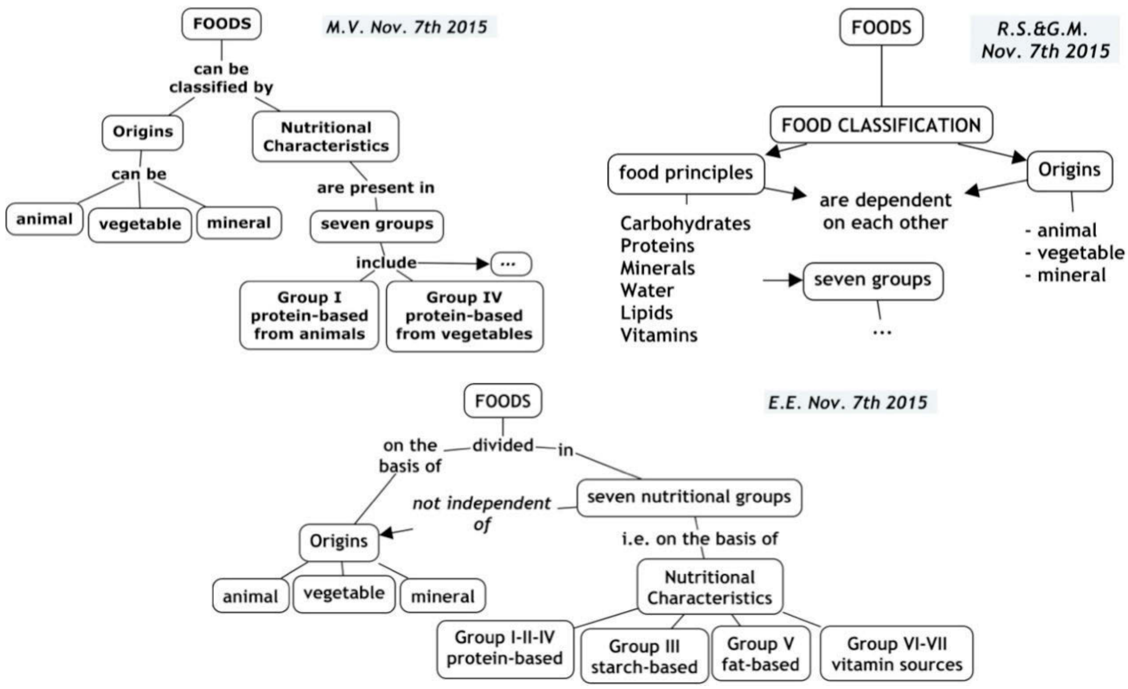

Figure 2. Only 7 student texts by 20 included an answer to the focus question. M.V.’s answer was the best one, but the animal and vegetal origins in groups I-IV were not made explicit (and maybe aware to M.V.) as it could have by means of a cross link-relationship to “Origins” concept. E.E. made an inexplicit dependence relation (also in her text) of nutritional groups with food origins; R.S.&G.M dependence cross-link between principles and origins was inacceptable also in the text answer, as was made in other 4 concept maps.

After the concept mapping training, two tests in November and December 2015 were used to attempt ranking students ability in constructing concept maps. In each testing session, students had an hour or more to answer a focus question by constructing a concept map of a complete topic. The following parameters were evaluated: answer to focus question (AFQ); distinction of linking phrases from concepts (DLPC); quality of propositions (QP); extent of revision needed (ER). The first two parameters were assigned 0 to 3 points without any explicit quantitative criterion; to QP 0 to 4 points, in reason of ratio of correct propositions by total number of propositions. The fourth parameter was inversely ranked from 3 (misconceptions and great amount of revision needed) to 0 (no revision needed), therefore it was subtracted from the sum. This gave a grade from zero to ten to the c-maps.

Then the class was divided into two homogeneous groups *M* and *T* on the basis of the concept-mapper-ranks. The parameter QP was the most correlated with ER parameter ($r^2 = -0.74$ in the first test and $r^2 = -0.64$ in the second test), so only the two parameters QP and ER were averaged for the two tests and taken in account to construct two rankings of the 24 students which resulted closely comparable. The two rankings were divided in 5 blocks of same score and one half students in each group of scores was randomly chosen for the "cmapper" group M, while the remaining members were recruited as "text writers".

Group *M* average rank was 3.3, with st.dev. 1.5, while *T* group resulted in average 3.5 and st.dev. 1.8. During January 2016, group *M* mapped syntheses about four lessons, in which new topics were being proposed, while group *T* wrote the synthetic answers to the same focus questions as plain texts.

A multiple-choice test to assess the concept mastery was assigned at the end of period (5th February 2016). The scores of *M* and *T* members were compared. The *M* grades averaged 7.6 (st. dev. 2.3) whereas the *T* group average score was 8.8 (st.dev. 2.0). Thus, there were no significant difference ($\Delta = 1.2$ vs overall st. dev. = 2.2), notwithstanding there was a significant correlation ($r^2 = 0.52$) between the rankings as concept mappers and the test score of the entire class. The same significant correlation ($r^2 = 0.53$) was confirmed at the end of the following month, in which students of groups *M* and *T* exchanged their roles. In the assessment test of 4th March, the *M'* scores averaged 6.3 (st.dev. 1.2) while *T'* group average score was 5.6 (st.dev. 1.0). Once again there was no significant difference ($\Delta = 0.7$ with an overall st. dev. = 1.1). It was the same group of students (*T*, or *M'*) who scored hardly better than the other (*M*, or *T'*) independently of the use of short texts or concept maps to elaborate the answers to the focus questions as a synthesis of the main concepts discussed in the lessons.

The appreciable correlation $r^2 = 0.5$ of concept mapping rank versus the scores of two different tests can be interpreted as a consequence of a multifactor development differential, that influenced all the four tests (two concept mapping tests and two multiple choice tests). In a third, later assessment test for conceptual mastery (23th April) of the same kind of multiple choice, the correlation fell to $r^2 = 0.4$, whereas the correlation coefficient between 2nd and 1st test, that was $r^2 = 0.29$, collapsed to $r^2 = 0.08$ between the first and third test, demonstrating that some of those multifactorial limitations to development had been evolving in the long term, and this is also confirmed by the good news that some low-score students entered at the races.

Despite the limited impact of concept mapping activity, these practices resulted in a considerably improved attention and quality of dialogue in the class, helping students to concentrate on understanding while taking notes during the interactive lectures, and to focus on the very *most general concepts*. Furthermore, it became clearer and clearer the role and importance of *generalization* in the construction of the narration, in planning and bridging past topics with the new ones, as a way to construct a *mental system* of scientific concepts. It became also clear that the construction of student's single synthesis-cmaps of every new topic, was not the better choice. To capture the synthesis in concept maps was much a more cumbersome and incomplete process than writing an organic text that summarized the topic with the filter of a focus question. Concept maps were constructed on paper by necessity, due to the lack of readily available computers and Internet connection. These limitations impaired the effectiveness of this technique, the same possibility to quickly elaborate, edit and share the concept maps. On the other hand, the texts were always rapidly and meaningfully produced as valid syntheses of what was worth capturing. In the last lesson of this first phase, two different focus questions were assigned, one – simpler - that was to be answered as a short written text and the other as a cmap, in the hope that this had facilitated the organization of concepts through a concept map. Once again, the task of synthesizing as a concept map was more time demanding and required to fix syntactic difficulties that weren't encountered in the text task, thus resulting in an activity lacking significance.

A radical change in the lesson plan and the strategy of using concept mapping were both needed. Thus, in the *second and unplanned phase* of this study, individual texting and concept mapping were substituted by other tasks, as peer-collaborative writing of simple phrases in which two superordinate concept-words were contained or answering in pairs to questions or simple problems which were prepared in advance. Then, a bottom-up concept map, prepared in advance, was shown and analyzed to review and strengthen the connections between the old and the new concepts and to fix the role of the unfamiliar concepts contained in the phrases, questions and problems. The process of bottom-up concept mapping will be discussed in the 5-6th paragraph.

3 The psychological basis for the development of generalization

Beginner learners of scientific subjects at secondary school level, are placed in front of a "conceptual mountain", without the necessary equipment and abilities: thinking in concepts, metacognitive and problem solving aptitudes, experience of application of all these processes. The external resources to climb that mountain are situated in the "roped party": the learning community which the learner is part of, the concepts, particularly the "peaked" ones, i.e. the *most superordinate and generative concepts*. Therefore, the most necessary tools are part of the obstacle: out of reach of the learner, while the internal resources are formed by the developing system of mental functions: memory, will, attention, imagination, perception (Mahn, 2016).

In the highly cohesive psychological system, as shown in the following Figure 3, the dramatic change that accompanies the appearance of thinking in concepts, when the adolescent becomes aware of her or his own thinking processes, can be only comparable with the analogously revolutionary change in perception that was caused by the acquisition of language, with its reflexes in the other growing functions.

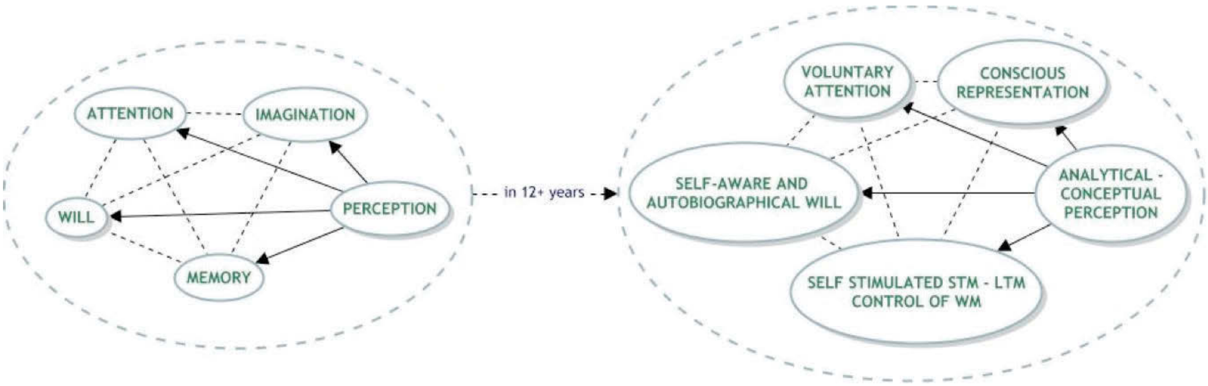

Figure 3. The five mental functions as they mutually affect each other, their own changing nature, the reciprocal laws of interaction while they evolve together with the whole psychological system and organic development, determine the development of psyche.

Volition (voluntary control of the use of concepts), rise of conscious awareness and systematicity (organization of concepts into systems in which there are subordinate and superordinate concepts) are interrelated characteristic descriptors of what is globally called "thinking in concepts", stemming from the development of previous - more elementary - structures of generalization called "complexes" by Vygotsky (1987).

In the stage of complexes, it is only possible to use language to unite "complexes of distinct concrete objects or things on the basis of objective connections, connections that actually exist among the object involved", while to think in concepts means to think abstractly, or to "view these isolated, abstracted elements independently of the concrete and empirical connections in which they are given" (Vygotsky, 1987, p.135, 156).

When this happens, the mediator discovers not only that the abstract level of generalization becomes possible, but also that this is somewhat *needed,* or "claimed" by the learner. But, the fact that the "transitional adolescents" are becoming prone to this higher process of generalization, does not imply that they will be able to do it autonomously or automatically. Rather, once the psyche has matured to make *possible* this specific qualitative leap in the process of meaning-making - typically in the age of adolescence - whether it will be actualized or not, depends on the presence of appropriate stimuli and sociocultural interactions in a fertile mediative environment.

The development of the five mental functions in Figure 3, besides being highly interconnected, as a background of psychical maturation, is also positively affected by the ability of working with concepts. It would be an error to believe that a single mental function (e.g. working memory, or attention) could be developed independently by the others to establish or improve thinking in concepts. Rather, exercising with the proper mediational stimuli to scaffold generalization, will foster analytical perception, awareness of the representations, control of working and long term memory, and so on. As for a muscle, the specialized use creates control and aptitude, as well as repeated control and exploitation of one aptitude, “specialize” the muscle.

In scientific subject matters as chemistry, there is the largest gap between everyday concepts and academic or scientific concepts. Generalization, conscious awareness and construction of systems of meanings are instrumental in expanding the “zone of proximal development” of the individuals in the learning community, in such a way to narrow the gap, by stretching the everyday concepts up, and reaching down from the general-academic and conscious concepts to what previously was going on spontaneously (Mahn, 2015).

A favorable educational environment adopts a series of scaffolding actions that imply a high rate of interactive speaking as imitation, development of examples, guided generalization, peer activities, plenary discussions, debates to reach a consensus, activities of writing and comparing written argumentation, short summaries, individual or collaborative concept mapping.

4 What is going on during the concept mapping of abstract relationships

One of the most common obstacles to the process of answering the focus question with a simple concept map, in the short term, as soon as a main idea was made clear, was that students didn’t know where-how to start (Kinchin, 2001).

This, in turn, can be understood as a consequence of the fact that a problem-solving like or critical-analytical focus question is better answered as an argumentative text instead of a structure made of ternary propositions hierarchically organized as a concept map. Organizing the conceptual structure can be considered as a second task, besides answering the focus question. Yet this task perhaps requires higher comprehension and awareness of the whole picture than the learners could have presumably got in the former stage of a new topic. There is also a third obstacle in constructing rigorous Novakian Cmaps, which is the syntactic one.

We see an example of how hard it can be to express, as a concept map, the fact (repeated from M.V. Fig. 2) that “a classification *based on the* kind of nutrient substances *is not completely independent from the* classification based on food origin, *because some of the* nutritional groups of foods *seem not to be only distinguished for their* nutritional characteristics, *but also for their* different origin, *despite these groups containing the same kind of* nutrient chemical substance.*”* (Italics for linking phrases, underlined concept labels). The argumentative answer by M.V. contains explicative and adversative connecting links, repeated concepts with similar meaning (e.g. kind of nutrient substance, nutritional characteristic). Moreover, it is not necessary to include the specific instances and every detail of groups in it. The *general concepts* are the only important ones to answer a focus question addressed to a critical examination of general relationships. In the textbook, the two classifications of food were considered as being independent. Therefore, the two concepts of *origin* and *nutritional characteristics* were expectedly mutually exclusive, whereas the true classification in nutritional groups is apparently more complex. So, *from the adult point of view*, we could elaborate a different perspective in which our cmap is a *description* of the most important classification in nutritional groups, instead of a comparison between two alternative classifications. The answer to the original focus question could be “embedded” in the description of the more systematic classifying criteria of nutritional groups, which includes food origins. But the real focus question would be now: “what are the criteria for distinguishing the seven nutritional groups?” This change is needed if we want the answer to be explicit. Nevertheless, these changes of perspective and focus question are out of reach of adolescent learners, whereas the plain text-answer falls within their ZPD, and it is equally useful to enforce the *general concepts* of *nutritional characteristics* and *homogeneous groups of nutrient substances*. Furthermore, both the adult concept map and student’s argumentative answer are equally likely to trigger or not trigger the need to question and investigate the actual nature of proteins in animal and plant food. Whether the deepening and further search of information would be stimulated by the constructivist activity (Wexler, 2001, p. 251) or not, depends on the amount of reflection that an adolescent learner may apply and, in the most probable case in which learner’s reflection is limited, it depends on the *degree of inquiry and awareness of the mediator*. This latter is another aspect that will determine the fundamentals and the role of bottom-up concept mapping. However, before giving our reasons for introducing a different use of concept maps, one more factor should be considered in examining what is going on when learners have to constrain abstract relationships between new general concepts into a concept map.

The learner has a pool of new and unfamiliar concept words in short-term memory and a focus question which invites him/her to examine the criteria of two separate classifications. The scaffolding of previous analysis of these criteria can be voluntarily rehearsed in the form of short claims which combine spontaneous, personal and vaguely defined concepts, and some of these new labels, in an unstable and fluctuating representative thinking. This is enough to saturate working memory and to eventually obscure the real nature of the task or problem. This latter could be neatly defined by the adult which already masters the system of concepts (inasmuch s/he has formulated the specific focus question), but the learner can hardly try to remember and assemble fragments of understanding of what was agreed during the discussion into plain written sentences, ignoring the formal - hierarchical structure of concepts. The learner just can't do all the same in the form of a concept map. The most likely outcome is a detailed "dumbing down" which s/he *describes* subordinate concepts (e.g. groups and subgroups of food in this example) almost ignoring the focus question.

Owing to these reasons the short texts in phase 1 outscored the cmaps in regard for pertinence of the answers to focus questions. A concept map autonomously made by a 15-year-old student is thus more similar to a way of ordering hierarchically a series of concepts and inclusive relationships, once these become completely elucidated and the student has gained conscious awareness. That was what happened in all the observed experiments during phase 1, and it is also what was observed in the study of concept map *complexity* by Dowd *et al* (2015), with older undergraduate students:

"We found no correlation between increased complexity and improved scientific reasoning and writing skills, suggesting that sometimes students *simplify* their understanding as they develop more expert-like thinking."

The wider hypothesis of this study is that to *simplify* understanding is equal to add clarity, differentiation and awareness to the high rank structure's concepts: those concepts that are usually overlooked as bare "title or subtitle-labels" when a lesson is given and attended.

5 Bottom-up Concept Mapping

The conclusion of the previous paragraph leads us to reconsider the "top-down" conception of concept mapping, deliberately entailed in the "expert skeleton concept maps" (Novak & Cañas 2010, Novak, 1983).

The common idea that more complex concept maps could be seen as indicators of better understanding has been previously criticized by Johnstone & Otis (2006): "Students with 'poor' maps were distributed, almost equally, between the lowest and highest quartiles [in the assessment batteries]", and more recently by Kinchin (2014, 2015). On the other hand, Novak acknowledges that *superordinate learning*, the opposite process "where several concepts are recognized as subconcepts of some more inclusive concept or proposition", occurs rarely, and "contributes significantly to development of cognitive structure, and this characterizes the knowledge of experts" (Novak, 2002). Along with Novak (ibid.), we agree that "superordinate concepts are relatively few in number in any knowledge domain", but not with the (apparently) logical consequence that "so most learning in usually subsumptive learning" (ibid.). The superordinate concepts are few, but also more abstract and hard to learn and incorporate in the classroom - everyday discourse. They have such an importance in meaningful learning, in thinking in concepts, and in the development of expert knowledge, that they should deserve more time and dedication in lesson planning. The teacher is there to mediate what is unlikely students would do spontaneously. Then, in order to compose the problem, we need to take into account three principles:

I. In the mediative environment learners can access superordinate concepts even though they are not expert, as long as the subordinate concepts fall within their ZPD. This is the objective led by the teacher-mediator.

II. Although superordinate concepts are relatively context-independent, it is essential that they are accompanied by some direct representation (direct observation, analogy, metaphor) and instances or context applications. Piihl & Philipsen (2011), refer to these terms as "mode 1 curriculum", that is the context-independent knowledge that learners acquire in lectures, can be better taught through a context-dependent setting (mode 2 curriculum), created by solving practical problems. This implies the teacher to be able to construct the knowledge domain in advance in novel perspectives and "flavors".

III. Therefore, the domain of superordinate concepts can be "constructed" and its epistemology creatively adapted to the needs of the class and even to the contingency in the program development, agreeing with Novak that "also the epistemological process where new concepts in a discipline are constructed, subject to all the human frailties we see in concept and propositional learning" are recognized (Novak, 2002). Eventually, we get to the main idea of phase 2, that is the ESCM can be used as advance organizers, first, to introduce new themes with lots of examples and context - without expanding it, and subsequently it can be expanded uphill as well.

The remaining part of the study was directed at investigating the integration of ESCMs as advanced organizers to underpin superordinate learning and construction of the "whole picture" (especially in the transition between connected chemistry topics) while the class was progressing towards the end of course. This part of the experiment will possibly lay down the basis for a future experimental research setting, which will necessarily entail an evaluation of a different kind of syllabus development, characterized by situatedness, dynamicity, generativity and open-endedness.

The nature of the upward development of expert skeleton concept-maps was initially enlightened by the analysis of the following case, which was encountered during the first year course.

Every chemistry or physics textbook has a chapter or paragraph about rules for establishing the number of significant digits in the result of a mathematical calculation between data with given numbers of significant digits. As a meaningful learning test-bench in a first year class, an attempt was tried to convey the *reasons* for applying such rules, through examples, practical demonstrations etc. Anyway - independently by the correctness of students' calculations - there was a large percentage of students who didn't utilize such awareness in their assessment tests. They were not voluntarily using the high level concepts of *data*, *measurement* and *uncertainty of measure*. It became clear that both students *and textbooks* were unaware of the relationships between these concepts, so the following definition was utilized and mapped in a series of lessons:

"*numbers can be divided in pure numbers without meaning (e.g. 8.5 or 3/2) and numbers with associated informative meaning which we should name "DATA". Information data can be divided into two classes: exact data (e.g. the number of sides of a triangle) and measurement data; the former have infinite significant digits, the latter have a limited number of significant digits because they suffer from measurement uncertainty*".

Where textbooks begin with the latter of these six concepts, the students actually *needed* the two higher levels of superordinate concepts.

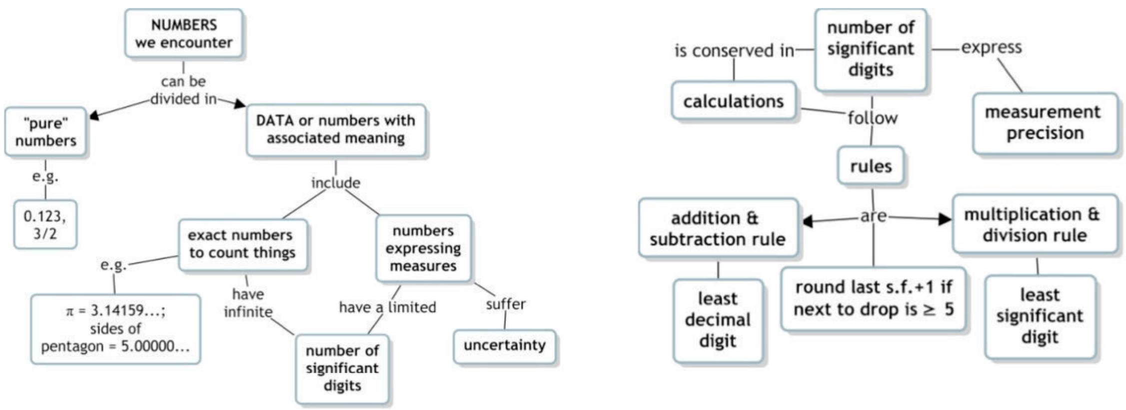

Figure 4. The left cmap was the first concept map developed upwards, to help students understanding rules of significant digits. The right "downward" map can be deduced from any textbook, where the most inclusive concept is exclusively context-related.

The concepts of *number of "significant digits"* and "*measurement precision/uncertainty"* can be meaningfully understood only in case they are subsumed under the concept of *data* and differentiated from *exact data*. Moreover, *data* concept should be differentiated from "number without associate information", or "*pure" number* to pretend the learner would discriminate between the meanings of *number* and *measure*. After the intervention, although the class had considerably improved in the second assessment test, they were still failing in distinguishing exact data from measurement data. After a close exam, it appeared that they had previously based themselves on an exterior (pseudoconceptual) element: the absence or presence of measurement units attached to the numbers. They had implicitly created this rule - to cope with the demanding - initially not scaffolded - conceptual requirement of distinguishing whether a data was exact or not. They were unable to voluntarily use representative thinking to make a clear distinction, because they were *observing the symbols instead of the represented things*. Two important issues are that *a)* textbooks do not specify that rules for significant digits don’t apply to pure or exact values, and *b)* the teacher was not aware of these obstacles to the understanding of such an apparently "simple" topic. Had he started from the beginning with that skeleton upward cmap and related examples, first of working with the rules, he could have saved a lot of time and obtained more abundant results.

We can generalize the findings by Dowd *et al*. (2015): "sometimes students simplify their understanding as they develop more expert-like thinking", as probably entailing that there are students with the ability to make more conscious generalizations and to fill autonomously the lack of specification of superordinate concepts which is typical of instruction, even among concept-mapper teachers. Only acknowledging this point we could hope to systematically empower both the "geniuses" and the "developing" students. By examining more cases of revision of the higher order concepts of knowledge domain, it became clear that:

1. It is the bottom-up exploration of a few concepts of ESCM that permits the teacher to “re-discover” and gain a higher level of awareness about the topic, as well as to find out new teaching strategies;
2. Mediation at professional level with adolescents can have more chances to generate conscious awareness and to open the trail to thinking in concepts if the teacher has a higher measure of awareness to transfer to the learner.
3. The concept maps that we were looking for were actually dynamical structures of mind, made of a reduced number of concepts (even just two) and simple inclusive relationships, the ESCM being just simplified advance organizers, artifacts to facilitate sharing and scaffolding.

Once the “trailblazer” role of the teacher was adjusted, it remained to establish how to regulate the development of the bottom-up skeleton concept maps in scaffolding the connections between learning units and in organizing the activities around these advance organizers. This will be exemplified in the next paragraph.

6 How to structure generalization

Every superordinate concept of a knowledge domain constitutes the basic-level concept of a previous or subsequent domain:

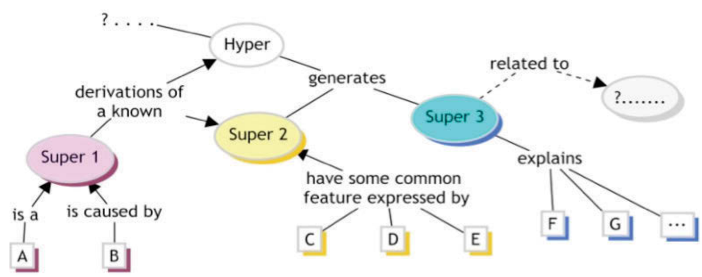

Figure 5. A sequence of generic sub-domains or learning units can be viewed as sub-structures having at least one common superordinate concept. Linking phrases and arrow lines show typical bottom-up inclusion relationships. These can be easily reverted to usual top-down - inclusive - links when substructures are constructed piece by piece from basic concepts A, B, C,...

Once the basic-level concepts (rectangles in Fig. 6) were introduced, several focus questions, probing questions, concrete examples and laboratory demonstrations were used to help the representational thinking to do the upward step to the superordinate concepts (ovals in Fig. 6) and to connect these latter to others. In this way superordinate meaningful learning was possible every time a difference, a regularity, analogy or commonality was *perceived*. Figure 6 shows a merge of ten bottom-up cmaps constructed-used during phase 2 of study.

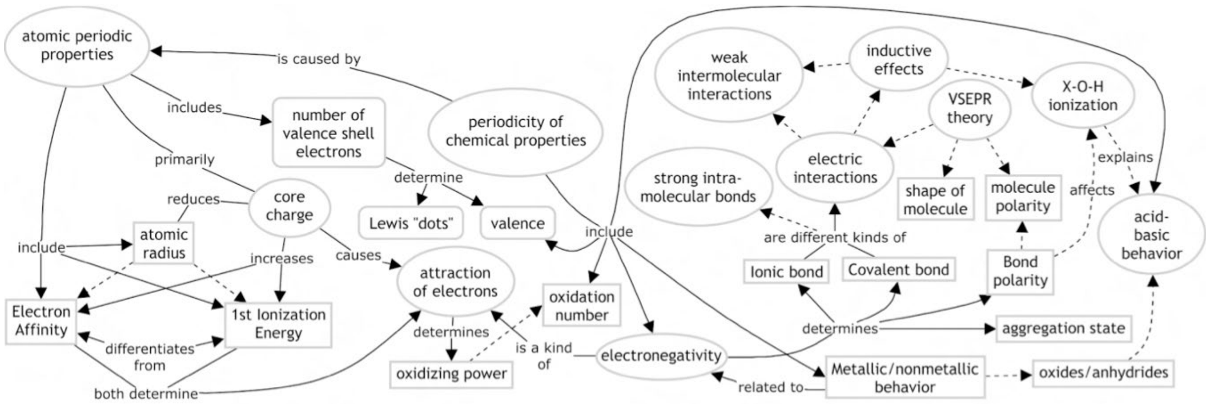

Figure 6. Summary of 10 bottom-up connected concept maps and learning units about12 key superordinate concepts (ovals).

The effect of bottom-up strategy is equivalent to Bruner's "spiral" curriculum (Bruner, 1960), because of recursive reinstatement of previous intuitive superordinate concepts ("great issues") on different grounds and psychical resources of learners, with two differences: here the recursion time can be as short as one month, and the curriculum is dynamically and sensitively created to suit the class, not "respectful" of a given standard.

To establish and reinforce the higher order relationships between any new-unfamiliar superordinate concept and a given basic-level concept, during the late experiments a task was assigned that consisted of writing meaningful propositions - that contained a couple of concept labels - in peer collaboration. Also proper focus questions were used in connection with construction of bottom-up cmaps to solicit *progressive differentiation*, *combinatorial learning* and *superordinate integrative reconciliation* (Novak, 1994) between similar or unrelated basic-level concepts. The next bottom-up Cmaps have been developed and connected during April 2016.

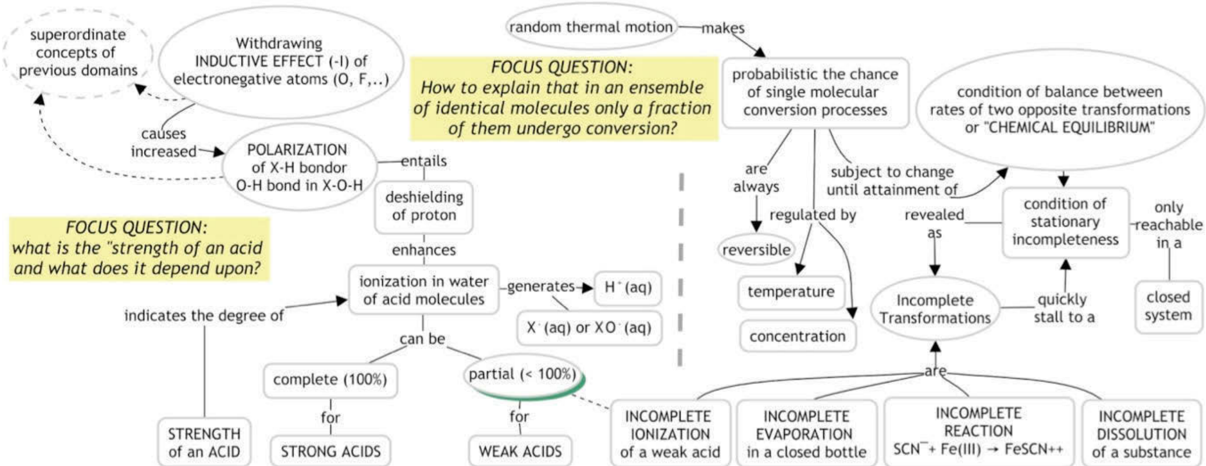

Figure 7. The two bottom-up learning units have been applied and used as advance organizers in multiple activities, including top down development of concept maps of some basic-level concepts. The two units are united by the basic-level concept of "incomplete ionization".

After the unit dedicated to chemical equilibrium and its generalization, the class went back again over the concepts related to acid & base, developing the domain in a more rigorous and less intuitive mind setting, thanks to equilibrium concepts. This creative form of "spiral curriculum" maximizes the connections (*integrative reconciliations*) and optimizes the construction of systems of scientific concepts, i.e. "maps *in the brain.*"

7 Summary

A qualitative leap in adolescent learner capacity to think in general concepts can be trained by helping them to assemble and perceive those ways of thinking that they had not previously combined, as long as these capacities have been matured in their zone of proximal development. In the *bottom-up* strategy each novel arrangement of relationships among concepts are designed as simple advance organizers, in the form of expert skeleton C-maps (ESCM), led by superordinate concepts that can be purposefully expanded upward as well as downward. What is critical with these organizers is not whether they are comparative or expository (Woolfolk, 2010), but that they are effective in transferring teacher's awareness to the learners, an objective that can be obtained even with a *single* overarching concept, like the *atoms* concept in Fig.8.

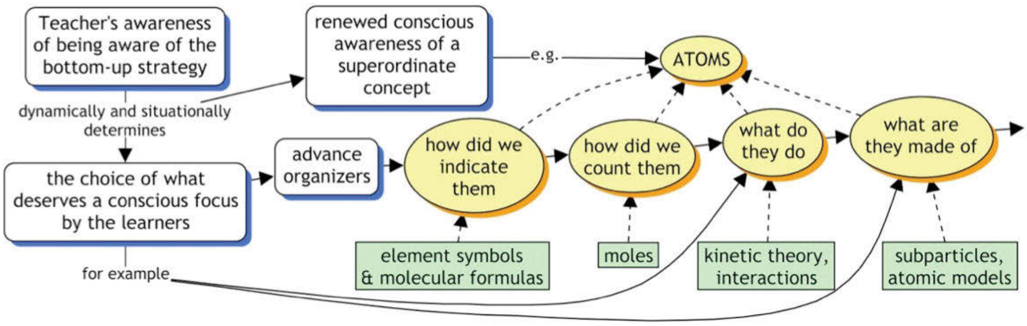

Figure 8. Bottom-up strategy is based on the transfer of teacher's awareness to the learner. This C-map shows how the strategy was applied to a series of four first-class units, each one with its single-concept advance organizer, which recursively changed the *atoms* concept.

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CONCEPT MAP-MEDIATED INTERVIEW METHODOLOGY: EXPLORING GENDER IN ACADEMIC CAREERS

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Abstract. Why do women succeed in higher education—but only to a certain point? This paper develops earlier research on the role that prestige plays in academic careers, and aims to explore the extent to which prestige is a gendered concept in academia. Drawing on 30 semi-structured concept map-mediated interviews this project explored the gendered nature of the prestige economy in academia and subsequently how mid-career academic women strategise their career development, and what barriers they perceive. Concept maps were used to facilitate interviewees career planning, facilitate dialogue and provide an artefact from the interviewee's own perspective. In terms of prestige, women generally feel that men access 'indicators of esteem' more easily. Many women also had ambivalent feelings about gaining recognition through prestige: they understood the importance of status and knew the 'rules of the game', but were critical of these rules and reluctant to pursue prestige.

1 Background

Several decades of research have demonstrated that women continue to be under-represented in senior positions in higher education (Morley 2014; Dean et al 2009; White et al 2011; Doherty & Manfredi 2006). Eighty per cent of professors in the UK are men, whereas the only academic category where women are in the majority is part-time non-managerial roles (Equality Challenge Unit, 2013). Despite this, higher education institutions can often be "complacent about what has been achieved for staff and hence, to think that 'gender' is solved by having a majority of female undergraduates and a few female professors" (Deem, 2014; see also David, 2014; Leathwood and Reid, 2009).

While there are signs of improvement in some areas, others remain static or are worsening. For example, there is concern that the proportion of women at Vice-Chancellor level is on the decline (Bebbington 2012), while this year only two of the forty-three mid-career scientists awarded Royal Society University Research Fellowships were women (Royal Society 2015). These gender imbalances are compounded by wider forms of inequality and representation on the basis of 'race', socio-economic status, nationality, ethnic group, disability, religion, and geographic region (Banks 2002). The Equality Challenge Unit (2013) highlights the stark statistic that only 2.8% of Black and Ethnic Minority female academics are professors, in comparison to the 15.9% of white male academics who are professors (see also David 2014).

2 Academic Prestige as a Gendered Concept

Previous research on motivation on motivation has highlighted the role of prestige in hiring and promotion decisions (Blackmore & Kandiko, 2011). We use the term 'prestige economy' (English, 2005) to describe the collection of beliefs, values and behaviours that characterise and express what a group of people prizes highly. Evidence collected on publication rates, first author status and workload balance indicates that academic women find it harder to access the types of 'currency' that advance their career; we therefore consider prestige to be a gendered concept (Coate & Kandiko Howson, 2014). We are interested in how women perceive academic indicators of esteem and how they strategise their careers accordingly. We are also interested in the apparent individualisation of academic careers, and how this affects and is affected by gender inequalities.

This research examines the career strategies of academic women who self-identify as being at a mid-career stage. The research aims to share the strategies that women have found useful in developing their careers, while also arguing for institutional change. While focusing primarily on gender, it draws on feminist theories of intersectionality to consider multiple forms of identity (Crenshaw, 1991; Berger and Guidroz 2009; Jones 2009). This conceptualisation reflects a perspective of universities as highly complex sites where multiple and intersecting spheres of 'difference', including culture, ethnicity, gender, disability, socio-economic status and language interact.

3 Research Methods

This research is based on qualitative research methods designed to explore mid-career academic women's plans, aspirations and experiences. We interviewed thirty academic women from a variety of institutions who self-identified as being at the 'mid-career' stage. In this section, we outline our target group and our sample, and explain our approach to interviewing and analysis.

3.1 Mid-career focus

In considering women's academic careers and gender imbalances, research has tended to focus on academic women who are early-career researchers (e.g. Cole & Gunter, 2010) or those who are in senior and leadership positions (e.g. Fitzgerald, 2014; Hoskins, 2012; Dean et al, 2009; Doherty & Manfredi 2006). Valuable as this research is, it is also important to explore the experiences and perspectives of women who see themselves as being mid-career, particularly as this stage probably encompasses the longest period of most women's working lives. It may often be at the mid-career stage that women are thinking about promotion and leadership, or that they feel de-motivated, blocked or 'stuck'. As professional women tend to have children at an increasingly later stage, mid-career is also when academic women are most likely to consider having children. For all of these reasons, mid-career women are in a particularly challenging and interesting position in terms of their career plans and aspirations.

We recognise that the concept of mid-career is open to interpretation, and may feel different for individuals depending on their discipline, institution, confidence levels and other factors. For this reason, we invited women who *self-defined* as being mid-career to volunteer for this study. As part of the interviews we asked women what mid-career meant to them, and we discuss the 'neglected mid-career stage' later in the report. The majority of women who volunteered to take part in our study, self-defining as mid-career, were employed as lecturers, senior lecturers, senior research fellows and readers. That a handful of women professors, PhD students and post-doctoral researchers also volunteered to take part perhaps demonstrates the breadth of the term 'mid-career'.

3.2 Recruitment and selection

We recruited thirty women to take part in concept-map mediated interviews (see below). Aiming to speak to mid-career academic women from a diverse range of institutions and disciplines, we sent a recruitment email to a variety of institutional and discipline-specific mailing lists. We invited anyone who self-defined as a mid-career academic woman, working in a London university, to take part. We had positive responses from sixty women, of whom we selected thirty on a semi-random basis to maximise the diversity of institutions, disciplines and mid-career job roles. The thirty women we eventually interviewed were from nine different London institutions, and held a variety of job roles (lecturer, senior lecturer, reader, research associate, senior research fellow, senior investigator and interim school director). Participants were from at least seventeen different disciplines, with natural sciences represented more heavily than social sciences, arts and humanities. While some of the research participants were from Minority Ethnic backgrounds, most were white, and further research would be needed to explore Black and Minority Ethnic academic women's career experiences in more detail. The table in appendix 1 shows the participants' disciplines, job role, nationality and ethnicity.

While we recognise that interviewing thirty women can give only indicative results, and may be particularly limited in terms of making conclusions in relation to sub-groups (such as women in certain disciplines or from particular cultural backgrounds), the detail of the interviews and analysis nevertheless contribute to an valuable understanding of mid-career academic women's careers and decision making.

3.3 Data collection

We collected data through concept-map mediated interviews (Kandiko & Kinchin 2012; 2013). These were qualitative interviews that began with a request to participants to map out where they would like to see their career in five to ten years' time. Concept maps are a method of graphic organisation that can illustrate networks and links between themes. In practice, women drew a variety of visual representations of their future careers, some of which are included in this report. We then asked women to explain their maps, highlighting what would help them to achieve their aspirations, share any good practices they had experienced, and discuss any barriers they perceived. We also asked participants about what was valued in academic life, whether (and how) women communicate their successes, and whether (and how) gender and other social identities play a role. We finished each interview with a discussion of what being mid-career meant to the participants. We carried out thirty concept-map mediated interviews of around one hour each in October and November 2014. Interviews were audio recorded with the interviewees' permission, and recordings were transcribed.

3.4 Ethics

The recruitment email emphasised that women's responses would be kept confidential, and that interview excerpts would be anonymised in any publication or report by removing names, institutional affiliation, and other identifying details. All research participants' names in the report are pseudonyms. Participants were sent an information sheet in advance and were asked to sign a consent form, consenting to the recording of the interview and the storage of data. They were informed that they could choose to withdraw from the research up to the end of 2014. The project received institutional ethical approval from King's College London (reference REP/13/14-61).

3.5 Analysis

Thematic analysis was carried out, drawing on both the academic women's concept maps and the transcripts of their interviews. Analytical codes were initially developed after interviewing was completed. The research team drew on participants' concept maps to create our own analytical concept map, which identified emergent themes and tentatively linked some of these themes together. Interview transcripts were then coded using Nvivo qualitative analysis software, with new codes being added as necessary. While coding each interview transcript, each interviewee's concept map was consulted together with their transcript. Codes and analytical decisions were discussed iteratively amongst the three members of the research team.

4 Career Planning Findings

We asked women to draw a concept map or diagram of where they hoped to see their career in five to ten years' time. These concept maps represented a large variation in approaches to career planning. Some of the maps were detailed and clear, showing specific, measurable and timed objectives that led logically towards short, medium and long term goals. These women knew where they were going, and knew what they needed to do to get there. They represented themselves as assured planners with clear and often ambitious career paths, and felt that active career planning was a vital part of taking control of their lives:

The question is: do you go for the really professor route where you're staying research active or do you go down the management route? And I think that is the decision that gets made at this stage. And I guess I'm really keen that I make it, rather than it just kind of happening by default. (Fiona)

4.1 Strategy

The concept maps drawn by our interviewees gave clear and contrasting representations of their career plans. Wendy's concept map (below) shows her clear intention and hope to become a senior lecturer, then a professor, and eventually taking on strategic and managerial roles. She has mapped out how she will get there (via personal fellowships and a 'crucial period' building an international reputation) and the form as well as content of her concept map shows clear upwards progression.

Even for the most committed planners, however, five to ten year plans could never be entirely predictable. They depended on a number of factors, including publishing, job opportunities in other institutions, colleagues, grant income and family. Bernadette's concept map (below) is similar to Wendy's in that it shows an intention to become a senior lecturer and then professor, via a clear route of publishing and grants; however, its form and content are less assured, more circular and reflective.

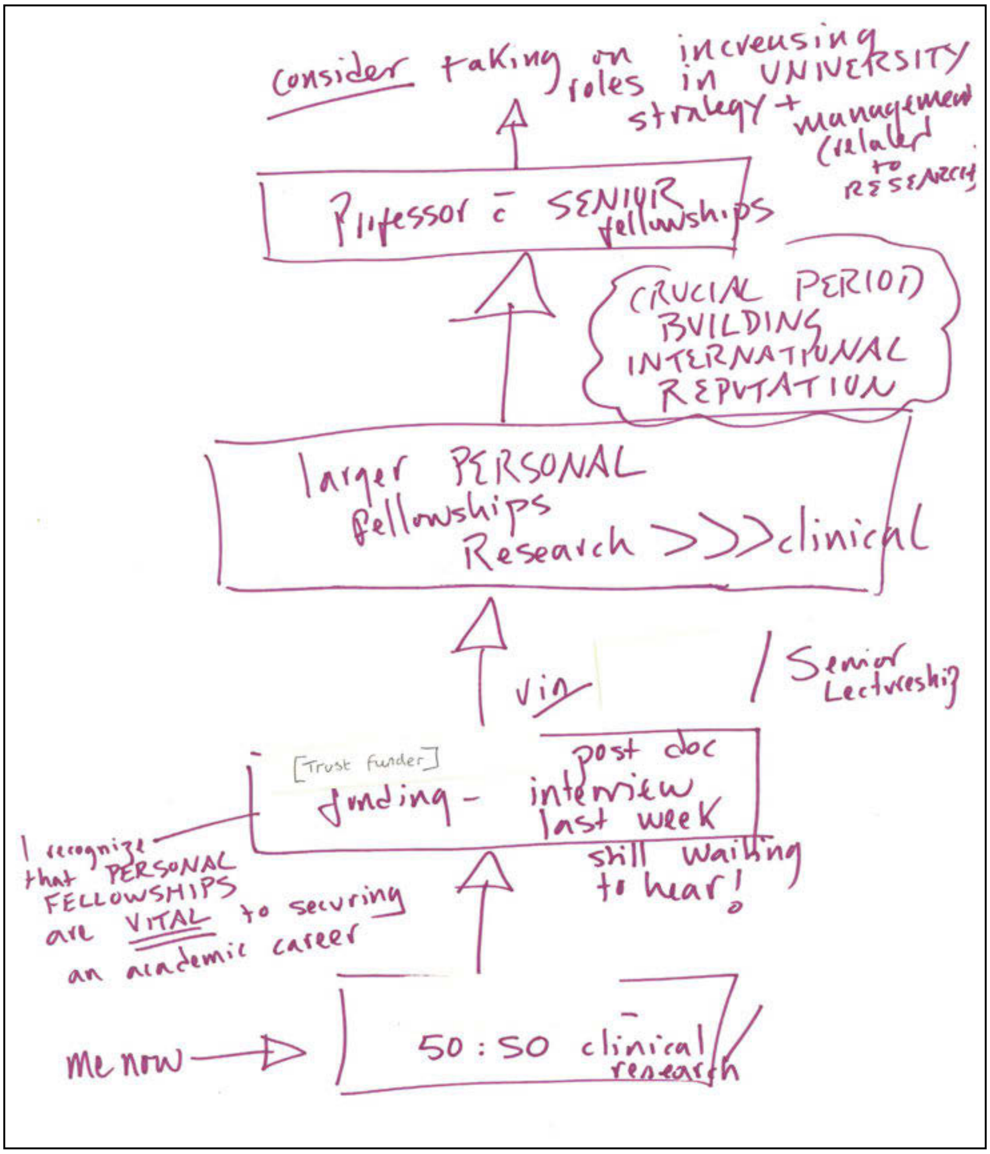

Figure 1. Wendy concept map

So, in five years' time, I want to be senior lecturer or reader... I want to publish my second monograph, I'm writing the book proposal for that now. That's to do with my second independent research project, big research project, after the PhD so that will feel nice. Big news is I'm pregnant... I hope that all of this is going to work out, childcare and career and so on... I'm finding it difficult to know where I'll be in ten years' time, it depends on so many things, such as job opportunities at other universities. Sometimes it's easier to get promoted if you just change institution a lot of the time; whether I'd have more children, whether I get more research grants. And long term career goal is definitely the professorship. (Bernadette)

Bernadette's map and discussion seem to signal some discomfort around the notion of being a good career planner. Some of the women who had clear career goals and pathways seemed almost to apologise for, or downplay, their careful planning:

I deliberately collaborated with people abroad and published papers with overseas collaborators to show international reputation and collaboration. I deliberately went for a large lecture course to the core of the students… I suppose it was strategic. Well, not that much, you know… it's rushing to juggle everything, really. (Beth)

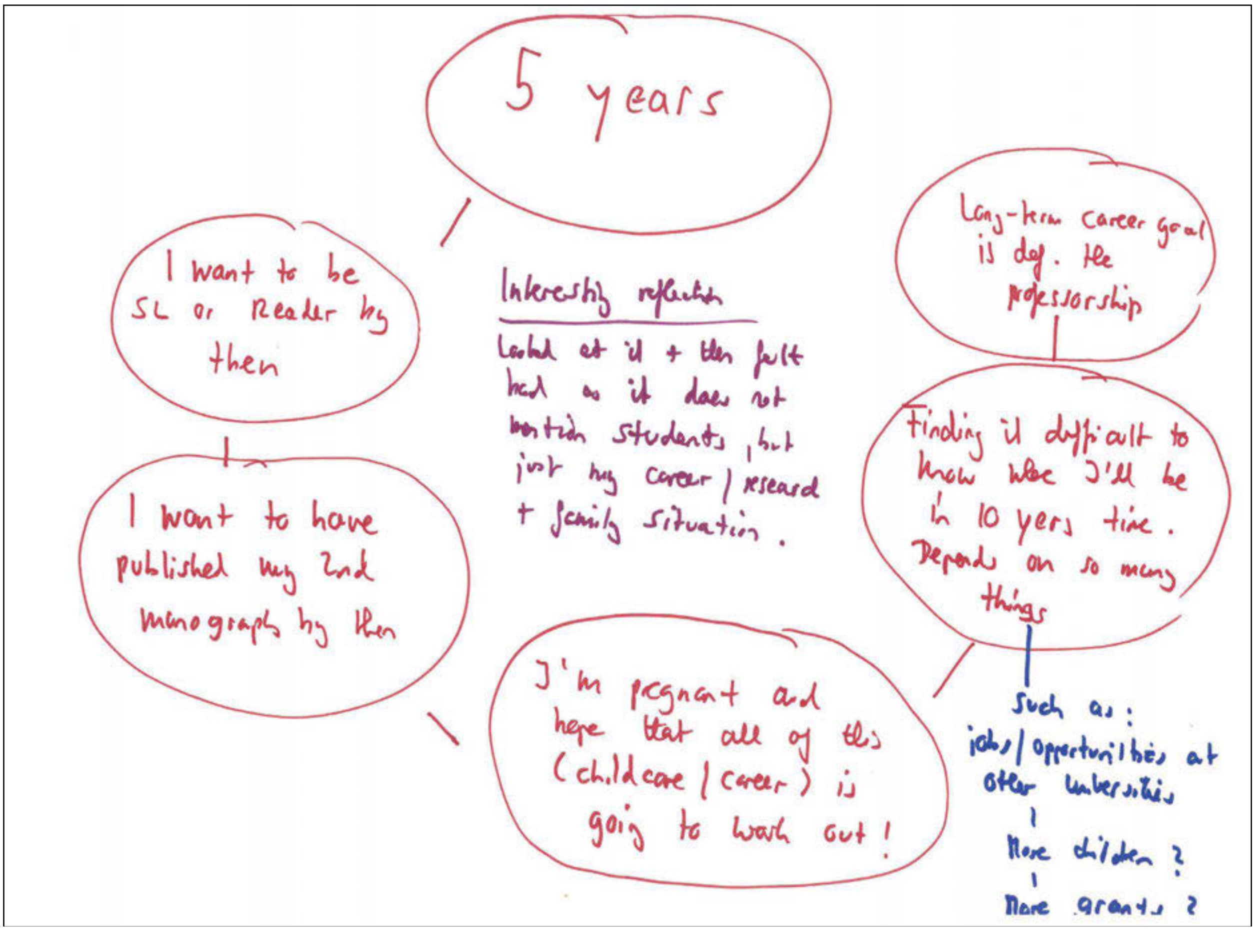

Figure 2. Bernadette concept map

Perhaps being a strategic and ambitious planner sits uncomfortably with other aspects of gendered and professionalised identities. In terms of gender, feminine 'norms' suggest a certain amount of modesty that conflicts with what might be seen as self-promotion. In addition, there may be conflicts between strategic career planning and the pursuit of academic values that emphasise the pursuit of knowledge, and often a notion of collaborative or collegiate working rather than personal ambition and progression:

I derive pleasure and satisfaction and fulfillment from excelling in that and doing it well, which means I'm playing the game, you know, in terms of participating in the REF, those kinds of things, which I also despise politically. But that is, I think, honestly, a part of it. I'd lie if I said it wasn't. (Bernadette)

Some women did not feel able to do what they felt they needed to for promotion to be a possibility. Nina describes being so burdened with teaching that she does not see how she will get ahead.

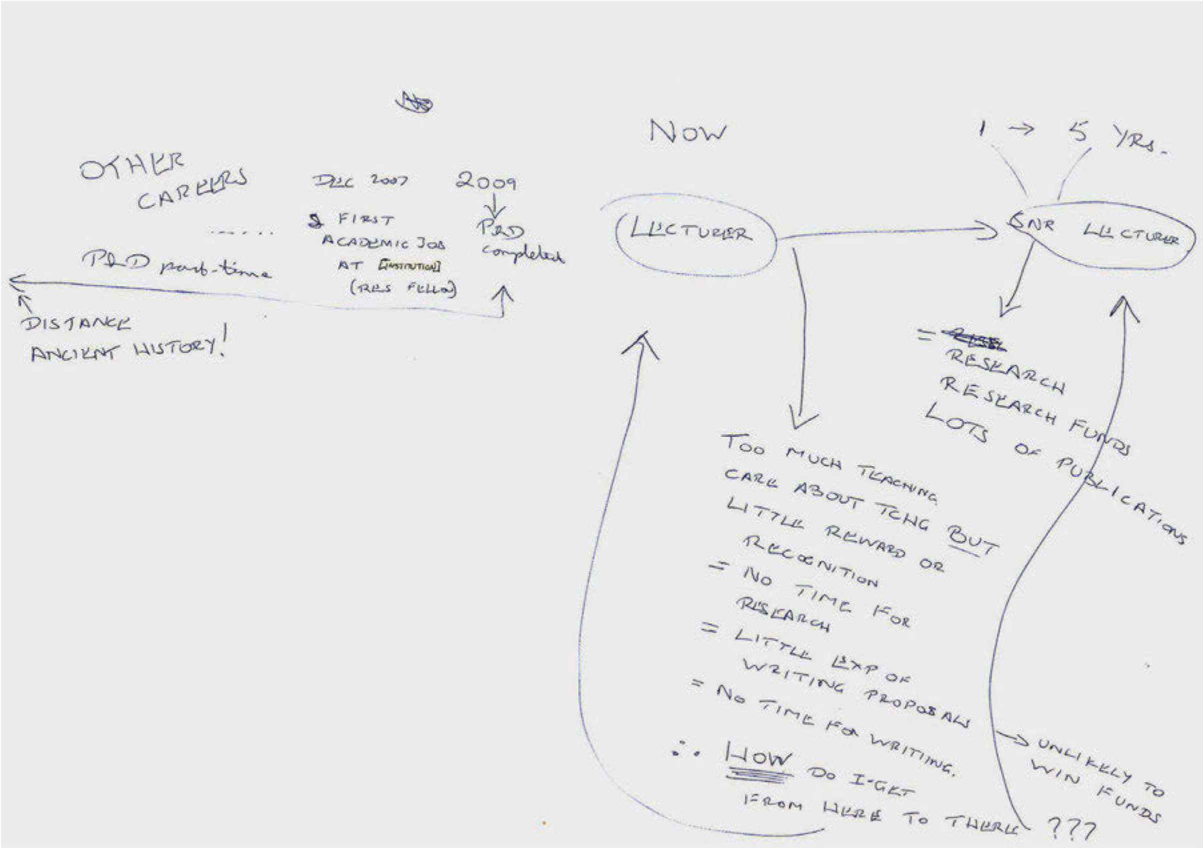

Figure 3. Nina concept map

4.2 Opportunistic

For other women, whose approach to career planning had been more opportunistic, their reluctance to engage in career planning meant that they had not been promoted as quickly as they might have been capable of:

I didn't bother applying for academic promotion for a very long time. And it never occurred to me that it was important. I always used to think, well listen, it doesn't really matter whether I'm a senior lecturer, a reader or a professor. It's the quality of my work that matters and I don't really care… And then only latterly it occurred to me... that I should have been promoted a long time ago and it would be a good idea. Because I was going to meetings where I would be the only person on the panel who's not a professor… And when I did the promotion to Reader I realised that I probably met the criteria quite a bit previously. (Yvonne)

In this context, it is perhaps unsurprising that many of the interviewees drew concept maps that suggested a lack of clarity over career plans, even feelings of confusion and frustration. Here, the individualised nature of women's academic careers seems to come across strongly: 'I don't see myself going that much upward in the next five years. Which I wouldn't tell anybody of course'. Women who do not progress quickly might blame themselves, and feel unable even to discuss their difficulties. The word 'stuck' came up in several accounts, at times as a cautionary word, a spur to start engaging more actively in career planning or job seeking:

I took the senior lecturer's job, which I've loved … it's a permanent contract, I do like that mixture of teaching and research... it is relatively easy to get to and having to be home to do the dinner and pick them up from after school clubs... I think I always thought maybe I've missed out on something, do you know, because there's a necessity to stay in the job and I see colleagues moving around doing other things, and I do feel a bit like, oh, I'm a bit stuck here, which was fine because, you know, I was bringing up my sons but in the last couple of years, they're… now my children are 19 and 22 ...they don't need me to come home and help with homework and whatever. (Pat)

While mid-career women (or at least those who took part in our study) generally identified their need to engage actively in career planning, this should not imply that women's careers must take a particular path. While nearly all of the women had wishes and hopes for how their careers would look in five to ten years' time, not all of these aspirations were related to formal promotions or leadership positions. Some simply wanted a slight change in balance rather than seeking a high status role:

Where do I see myself being? I think very much still teaching, so not move completely away from teaching, but along those lines with more choice and less the donkey work as it were. Donkey work being lots of marking. I'd like to have a bit more cross school contact and work with people from other schools, to have a bit of influence at higher levels in the future development of [the university]… And some staff management. So no major ambitions there, but these are the sorts of directions in which I can see myself moving in the five to ten year period. (Amanda)

It's a bit odd because I am quite ambitious in many ways but I've never, I don't want to just have status for the sake of it. I can't see the point… That doesn't do it for me. (Olivia)

4.3 Communicating

Women faced the challenge of both needing to tick all of the boxes to be eligible for promotion, and also communicate their successes to others. Several women mentioned that their achievements were not always noticed in their institutions, and they felt this was gendered. Ethnicity, 'race' and background are also likely to affect how experiences and achievements are valued; one academic woman attending an event where we shared our research findings noted that women from the Global South often have a wealth of experience and qualifications that are not adequately valued or recognised in the UK academic job market.

It is often assumed that the lack of value given to the achievements of women and people from ethnic minorities relates to a lack of self-promotion. Our research confirmed other research that suggests a cultural and gendered reluctance to engage in self-promotional activities (see Scharff, forthcoming):

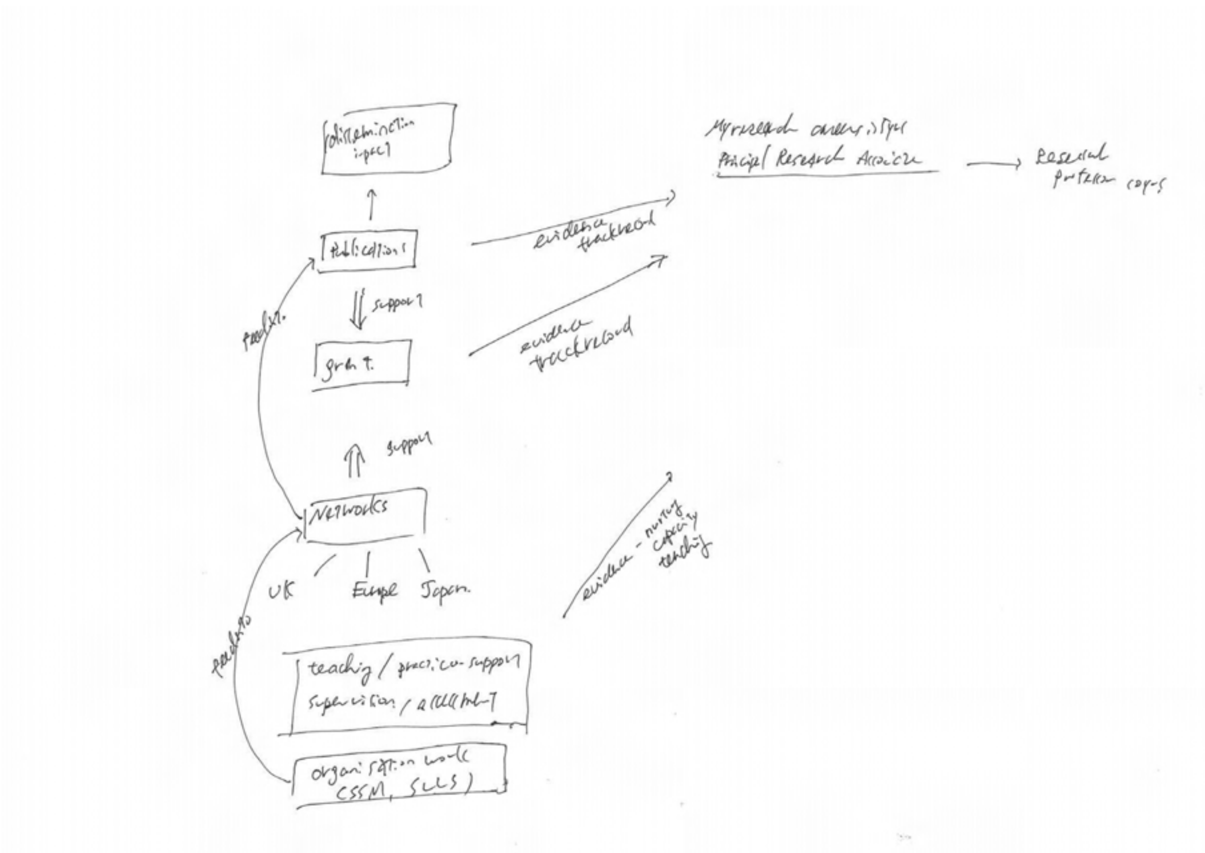

Figure 4. Haruka concept map

Well the thing is I'm not a sort of self-promoting person, it's not in my character. Maybe that is why I am maybe ignored in a way… I've really published but I don't talk about it… Maybe that's something there where I should be more tactical about making an impact. (Haruka)

People don't want to talk about being the best or, you know, oh, 'I'm the de de de de. I got an award for de de de de'. It's like, don't boast about it, you know... it's kind of, like, that British mentality, isn't it? You know, let's not shout about how great we are. (Lara)

Japanese women are brought up to be modest, but in the academic world you have to be, you know, present [that] you're very good, which I'm not really good at doing so far. So to say I'm reasonably good, I have to achieve much more. (Janeru)

As the map above shows, Haruka has a clear pathway (drawn from bottom to top) that includes the publications she feels she has, but her reluctance to share her success hinders her achievement. However, this should not suggest that women should become 'more like men' in selling their achievements. While women's career development schemes often include an element of encouraging women to be better at self-promotion, some women in our study questioned whether this was healthy for academia. This is a particularly important point at a time when it seems that academia is becoming *more* dependent on cultures of self-promotion. Academics are increasingly required to be entrepreneurs and to measure and prove their progress against varying goals, as Stephen Ball (2012) suggests:

Last year's efforts are a benchmark for improvement – more publications, more research grants, more students. We must keep up; strive to achieve the new and very more diverse targets which we set for ourselves in appraisal meetings; confess and confront our weaknesses; undertake appropriate and value-enhancing professional development; and take up opportunities for making ourselves more productive (p.19).

This critique was confirmed by a feeling amongst some interviewees that the goalposts keep moving; that what is valued by certain institutions is not consistent, but changes frequently according to economic and policy factors:

One year they'll say they value bringing in research money, but then if you bring in research money they'll say, 'oh, no, actually what we value is bringing in students', and then if you bring in students they'll say, 'actually what we value is publications'... What I value is being a good teacher, you know, doing solid research, but… I don't think that's valued here. (Abby)

Even some of those who felt they had been relatively successful in 'playing the game' were critical of what counts as valued and prestigious. The willingness to self-promote and 'play the game' is gendered and yet this should not suggest that 'all women' are modest while 'all men' sell themselves. The reality is more complicated, with many women engaging in self-promotion and doing well in the prestige economy. What we suggest here is that it is not sufficient to 'train' women to be better at 'playing the game', even if this might be necessary to tackle glaring inequalities at senior levels. It is also important for academic institutions to reconsider what is - and what is not - considered prestigious. In particular, institutions and departments should think about how activities that could perhaps be attached to collective values - such as teaching, education and outreach – can be sufficiently celebrated and rewarded:

I spend a lot of my time talking to people... writing reports for governments, you know, doing the kind of advocacy work... And that doesn't count. I don't get publication out of that. I don't get grants out of that. It takes a huge amount of time. It takes a lot of energy as well, and it's absolutely counted for nothing in an academic environment. But to me it's the most important thing, because if we're trying to achieve the goal of providing services for people that don't have them, that is the most important thing to do. (Elaine)

It was clear that a number of women found it frustrating that the types of things that motivated them in their work were the least likely to be the things that receive recognition and reward. Women sometimes had very ambivalent feelings about prestige and reward, especially if they were able to accrue it while wanting to downplay its importance.

5 Summary

Overall, women's approaches to career planning were enormously varied, as might be expected. At the mid-career stage, women are often actively engaged in contemplating their careers, and have a complex set of considerations to take into account when doing so – encompassing emotions, values and family commitments as well as the more formal aspects of promotions criteria, job opportunities, grant applications and prestigious publications. Their aspirations change depending on these considerations, and career plans are sometimes put on hold, slowed down or sped up at different times.

For this reason, we need to be cautious in making generalisations about what mid-career academic women need and want in terms of career development. At times, they may need encouragement, a 'push' or simply a lack of barriers to aspire to the next level. At other times, they may need to be valued for their current work without any implied or explicit pressure to aim for more prestigious roles. It is also important to think further about the individualistic nature of academic careers. This individualism exacerbates the sense of having to be ambitious, to strategise and make plans, and to juggle everything. It also reinforces the belief that it is the responsibility of the individual as to whether progression is achieved or not, and downplays the role of structural inequalities and barriers that are related to gender, class, 'race' and ethnicity.

Perhaps what is most important is that mid-career academic women are given regular space, encouragement and support to assess their career goals and aspirations as they change and develop. Women should not be pigeonholed as being either ambitious or not, as they are very likely to change their priorities at different times, and need to be supported in their current roles as well as in their plans to develop themselves and aspire to new roles.

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CONCEPT MAPS AND LANGUAGE ACQUISITION: AN IMPLEMENTATION WITH ENGLISH LANGUAGE LEVEL 2 STUDENTS

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Abstract. Concept mapping is a powerful tool for teaching and learning. Since its creation, it has been transforming education as a way of 'learning to learn' and for assisting to convert information into knowledge. This paper presents the findings of a research project conducted using concept maps to teach and learn English as a foreign language in a large university in Curitiba, in southern Brazil. The research was developed with a group of 13, Level 2, High School English language students, during their academic term (lessons of 1h40m, once a week, for 16 weeks). Action Research was undertaken and 15 activities using concept maps were created during the term, of which 8 are described in this paper. Students provided feedback during the course and answered a questionnaire at the end of the term. Students' responses to the questionnaire were analysed qualitatively according to Bardin (2011) and with the use of Atlas Ti software for qualitative analysis. Concept maps were perceived as facilitators of language learning and comprehension and for promoting thinking in the foreign language (L2), with special gains in the learning of verbs, prepositions and new vocabulary as well as in the development of reading, writing and aural skills.

1 Introduction

Concept maps (CMs) came as an alternative to rote learning, promoting meaningful learning. Its practice encourages reflection, research, selection, analysis and knowledge construction, as well as fosters the development of responsibility, initiative and self-confidence. Considered by many as a powerful tool for teaching and learning, CMs are "a strategy to externalize the conceptual and propositional understanding one has about a certain topic" (Valadares, 2014, p. 62); they can express internalized concepts as well as those in the process of assimilation and comprehension (Cañas, Novak, & Reiska, 2012, p. 1).

CMs comprise both content and structure (Cañas, et al., 2012); the concepts presented can be linked to each other by a verb (or verb phrase), with or without a preposition; by a preposition; or by a connecting word that expresses the relationship between those concepts (such as "for instance"). Propositions or semantic units, formed by a [concept] + linking word + [concept], are the main units that compose meaning (Novak, 2010, p. 45); they are stored in our cognitive structure and the quality of their meaning is related to the clarity and precision of not only the concepts employed, but also of the verbs, prepositions or linking words used to connect them (p. 26).

2 Concept maps and foreign language (L2) learning and teaching

The use of CMs for L2 learning and teaching has had some attention. The study conducted by Lee (2013) focused on concept mapping as a pre-writing strategy to learn Korean language in a collaborative way. Research data indicated that the treatment group had considerably higher results than the control group in the five criteria assessed, with special gains for Content, Organization and Vocabulary, and the result for Language Use and Mechanics were higher in the collaborative group as compared to those of the students working individually. Lee confirmed his hypothesis that "concept mapping activities may have the potential to have significant impact on the quality of writing when used as a learning activity in a prewriting phase of compositions." (p. 257).

Tezci, Dermirli and Sapar's research (2007) was on the use of CMs for L2 vocabulary acquisition. For the authors, a CM is a heuristic device and as such it helps learning by allowing students to see, read, write, and alter concepts. As students see same theme concepts interrelated in the CM, this promotes assimilation, potentializing contextual comprehension which, for the authors, is one of the main goals in language teaching. The authors claim that CMs can be used in language teaching not only for "presenting information by teachers, and students' management and evaluation of their own learning", but also for promoting the learning of: a word and related vocabulary; how words are used; how to read and write them; their grammatical structure; and how they aid text comprehension and vocabulary expansion (pp. 4-5).

Chularut and DeBacker's investigation (2003) concentrated on the effectiveness of concept mapping on students' achievement when learning from English language texts. The study involved the creation of CMs and concentrated on their relationship with the use of self-regulation and self-efficacy strategies for language learning related to four variables: achievement, self-monitoring, knowledge acquisition, and self-efficacy. Research findings revealed higher gains in the four variables for students who used CMs than for students who employed their own learning strategies.

In The Language Learning Lab – LAPLI (Marriott, 2004), a methodology for language learning that combines face-to-face and online learning, students built collaborative CMs, negotiated the selection of concepts and linking words and the inclusion of cross-links. Research data revealed an enhancement not only in their linguistic skills but also in their argumentative and persuasion skills when debating about how to build the CM and how to express their understanding in the Cmap (Marriott, 2010). Torres, Kucharski and Marriott (2014) assessed the use of CMs as a pre-writing activity with post-graduate Education students at a Catholic University in Brazil. Although the study's objective was the development of autonomy, interaction and critical thinking skills in Inquiry-based Learning, with respect to students' linguistic skills research data revealed better text comprehension, more confidence in the writing of scientific texts and in the production of knowledge as well as in the structuring and organization of ideas.

3 Pedagogical implementation

The pedagogical implementation reported in this paper (which is part of a 2-year doctoral research project involving 7 groups of English as a Foreign Language (EFL) students at 6 different proficiency levels) was developed in a state university in Curitiba/Brazil. The researcher, who was one of the members of a research group that focuses on Innovative Methodologies, Concept Mapping and Information, Communication and Technologies (ICT) in Education, set out to investigate the potential of using concept maps for foreign language learning and teaching. This implementation was carried out in a Level 2 class with 13 EFL students who met for 1h40m-lessons once a week for a period of 15 weeks. The 15 activities created using CMs are presented in Table 1.

E2 – List of Activities Developed	
Activity 01	Course content – interactive presentation of CM by teacher
Activity 02	Learning how to CM & Getting to know each other – Development of aural and writing skills (Creation of CM (V1 & V2); oral presentation in pairs; creation of 2nd CM (V1 & V2); writing based on CMs.)
Activity 03	Unit 3 – What's the weather like? - Development of aural, reading and writing skills with Mini-maps (Research on the Internet; data collection, pair work; reading; creation of CM (V1 & V2); assessment using Formative and Summative Assessment Table (FSA Table).)
Activity 04	Unit 3 – Focus on Grammar – *Present Continuous* (Interactive presentation of CM by the teacher, eliciting examples from the students.)
Activity 05	Unit 3 – What are you doing? - Development of aural skills (Pair-work using Mini-map.)
Activity 06	Unit 3 – Focus on Grammar – *Present Continuous vs. Present simple* (Pair-work: students interview each other on daily habits and routines, based on CMs.)
Activity 07	Unit 3 – Storm chasers - Development of reading skills (Access to links and audios on the Internet; creation of CM (V1 & V2); selection of root concept.)
Activity 08	Unit 3 – Focus on Grammar - *Present continuous* with future meaning (Interactive presentation of CM by teacher; creation of mini-maps to interview classmates; research on the Internet on weather-related free-time activities; group work.)
Activity 09 ASSESSMENT 1	Topic: Why learn English? - Reading & exercise; creation of CM (V1 & V2); selection of root concept; addition of personal information to CM & writing, assessment using FSA Table.
Activity 10	Unit 4 – Top Sports in the World - Development of reading and aural skills (Research on the Internet, creation of collaborative CM; oral presentation - Carrousel activity.)
Activity 11	Unit 4 – Focus on Grammar – *Can* (Interactive presentation of CM by teacher)
Activity 12	Unit 4 – Shopping for clothes online - Development of aural skills and vocabulary acquisition (Visit to selected online clothes shops; imaginary shopping of complete outfits for winter and summer; interview each other using CM Dialogue Plan; description of what classmate is wearing using skeleton map; writing.)
Activity 13	Unit 4 – Focus on Grammar – *Possessive Pronouns* (Interactive presentation of CM by teacher; Family possessions: creation of CM (V1 & V2) from skeleton map; writing.)
Activity 14 ASSESSMENT 2	Topic: People's love of shoes – Reading & exercise; creation of CM (V1 & V2): How much do people love shoes? How much do I love shoes? , selection of root concept, addition of personal information & writing, assessment using FSA Table.
Activity 15 ORAL ASSESSMENT	Dialogue creation and presentation (Use of CM Dialogue Plan for preparing dialogue on course content, oral presentation to class.)

Table 1: English 2 (E2) – Activities Developed

From the 15 activities listed in Table 1, 8 were selected for presentation and discussion in this paper. The selected activities are presented as follows.

Activity 01/E2 – Course content – interactive presentation of CM by teacher

Presentation of course content via a CM provides a general overview of the subject matter. This overview enables going beyond the compartmentalization of knowledge to maximize comprehension of its totality in a networked and contextualized way (Behrens, 2008; Morin, 2007; Yus, 2002; Zabala, 2002). Figure 1 shows the content of Units 3 & 4 from students text-book (Seligson, Lethaby, Gontow, & Abraham, 2013).

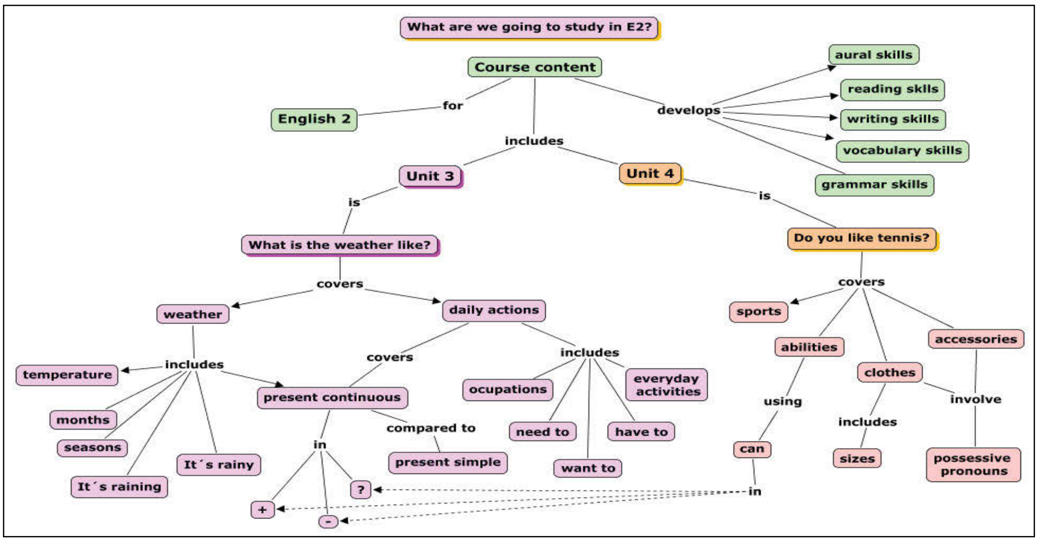

Figure 1. Presentation of course content

The goal of an interactive presentation of content (which includes eliciting examples from the students) is to promote access to acquired knowledge to foster meaningful learning (Novak, 2011). Besides introducing students to the concept mapping technique, this visual and oral presentation shows them how propositions are formed; how reading is done; how hierarchy is established; that it conveys a summary of the data, presenting general information but also focusing on more specific ones; it illustrates how concepts can be connected and also how cross-links (represented by the dotted lines) can be stablished.

Activity 02/E2 – Learning how to CM & Getting to know each other – development of aural and writing skills

To develop students' concept mapping building skills and for them to introduce themselves and get to know each other, they created a CM to answer the Focus question: What is unique about me? In this activity, the teacher was able to explain and explore how to form propositions by illustrating the importance of an appropriate selection of concepts and verbs (by covering the linking words in the slideware projection and eliciting new propositions from the students).

The steps of the activity were: (1) teacher introduced him/herself by means of a CM in the 1st person, answering the Focus question, using verbs/phrasal verbs/verb phrases such as: was born on, was born in, is, has, lived in, worked at, works at, enjoys, likes watching; (2) students built a CM to introduce themselves (V1-me); (3) students worked in pairs to introduce themselves by reading CM; (4) based on classmate's presentation of him/herself, students built a CM about him/her (V1-my) in the 3rd person; and (5) based on the information on the 2 maps, students wrote a paragraph about themselves (in the 1st person) and another about their classmate (in the 3rd person). While students were building their CMs, the teacher resolved all doubts that arose, taking the opportunity to revise verbs (in the different forms and tenses), the use of prepositions and vocabulary in L2.

V1-me and V1-my, created by student E2-10, were assessed using the Formative and Summative Assessment Table and V2-me is introduced in Figure 2 (the FSA Table, which was developed in this doctoral research, is presented and discussed in the CMC2016 Springer Volume). V2-me, produced by E2-10, could be defined as a spoke structure (Kinchin, Hay, & Adams, 2000), as most concepts relate to the root concept, and although there are still some ambiguities in his Cmap (pointed out by the letters and numbers in the boxes which represent the criteria in the FSA Table) it is a very clear and straightforward map, considering this is the first Cmap this students builds. The stars highlight appropriate linking words or concepts used and the blanked out concepts ensure anonymity of the participants.

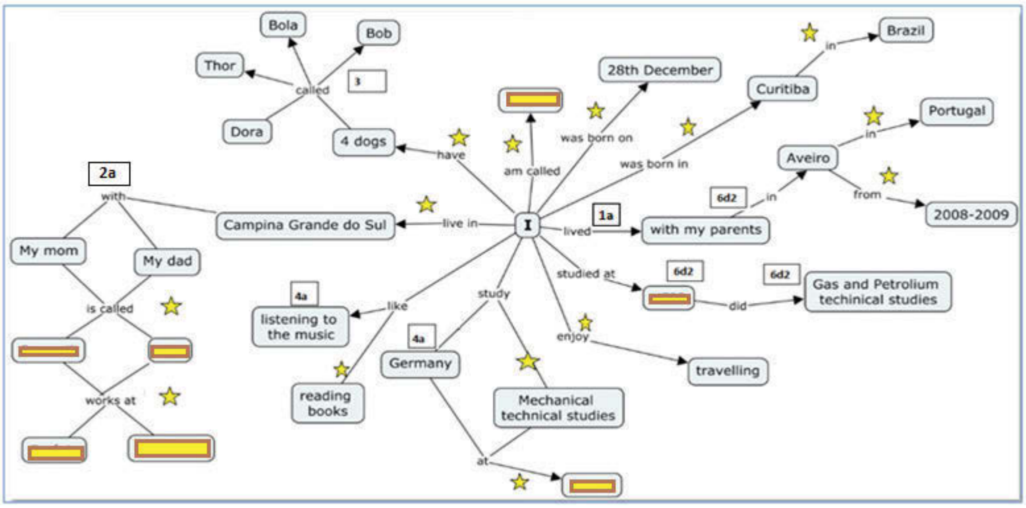

Figure 2. What is unique about me? E2-10, V2-me

Language acquisition is a complex, non-linear process and backslidings are part of this process (Larsen-Freeman, 1997) in the anchoring of new knowledge to the existing knowledge in the student's cognitive structure.

Activity 03/E2 – Unit 3 – What's the weather like? - Development of aural, reading and writing skills with Mini-maps

After eliciting students' existing knowledge about the weather with the question "What is the weather like now?", the teacher asked students to: (1) do some research on the Internet about the weather in their capital city and in other capital cities around the world; (2) fill-in a table in their course-books with new vocabulary; and (3) practice in pairs asking and answering questions about the weather at the moment (according to the website) and the usual weather in those locations (based on their previous knowledge about these capital cities). The pair-work activity was based on the Mini-maps (Figure 3) created and explored by the teacher.

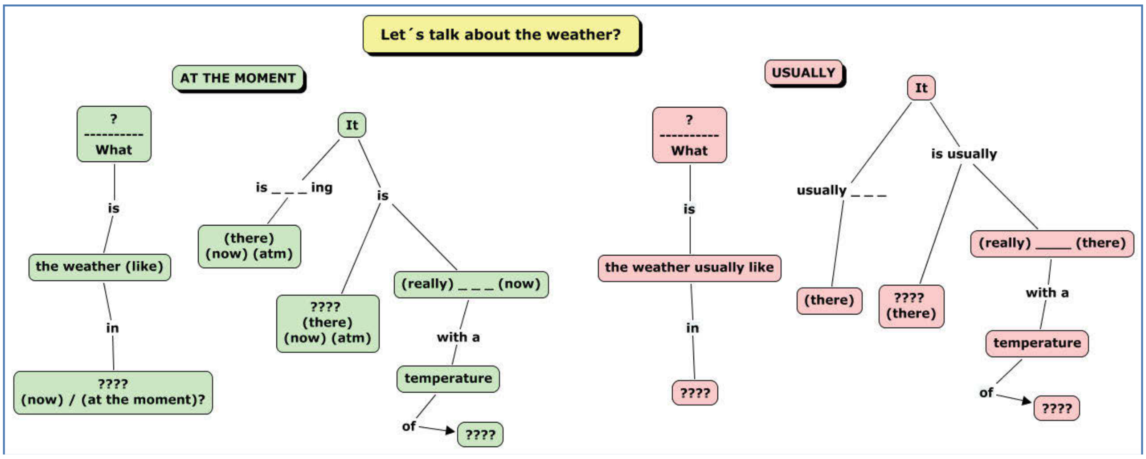

Figure 3. Let's talk about the weather? – Mini-maps

A Mini-map (MM) is a simplified version of a CM. It is one of the types of maps created in this study to promote "noticing" on the three dimensions of use, meaning or form (proposed by Larsen-Freeman (2001)) and to practice "grammaring" (which is not only the appropriate and dynamic use of grammar, but also its meaningful use (Larsen-Freeman, 2009, p. 526)). A MM is usually just a phrase and it is frequently practiced in pairs.

After practicing the MMs in pairs, students read the text on the weather in their text-book and, based on this information and the information found online, students built a CM individually to answer the following Focus questions: "What are the seasons in the countries around the world? What is it like in Brazil?" Versions V1 and V2 of their CMs were assessed by the teacher using the FSA Table (not included in this paper).

To keep track of all of the various versions of the CMs produced, the pieces of text written and their formative and summative assessment in the construction of knowledge, and in order for students to be able to reflect on them and to solve the ambiguities detected by the teacher on their work, the teacher asked all the students to keep a Portfolio of all the material produced, always keeping the most updated version on top.

Activity 04/E2 - Focus on Grammar – Present Continuous

The goal of Focus on Grammar activities, as well as of the Mini-maps, is to promote a shift of attention from the general overview of a topic to a particular aspect in L2 acquisition. CMs created to this end sometimes display "functional concepts" (in grey, square boxes) that are not uttered but either give an explanation or help form a proposition with [concept] + linking word + [concept] in questions (which normally start with the verb) and when using intransitive verbs (such as "dreaming"). Various colours are also used to highlight the different forms, persons and verb conjugations (Figure 4).

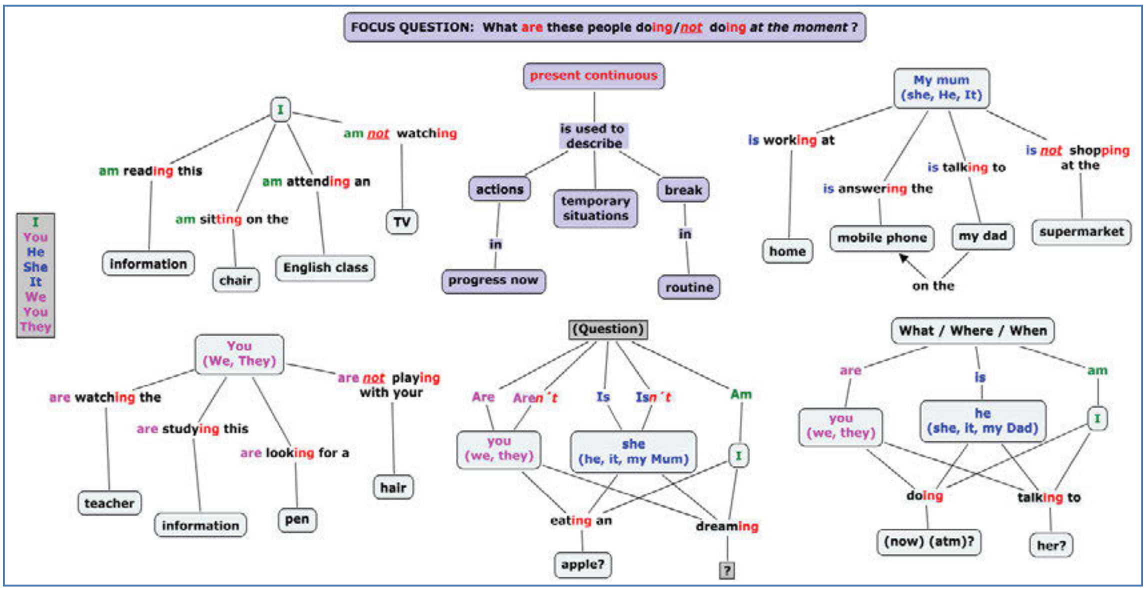

Figure 4. Focus on Grammar activity: presentation of the Present Continuous Tense via Mini-maps– E2

After an interactive presentation of MMs on the Present Continuous, to activate their existing knowledge and promote meaningful learning, students practiced this grammar point in Activity 05/E2.

Activity 10/E2 – Unit 4 – Top Sports in the World - Development of reading and aural skills

To activate students' knowledge, the teacher led a warm-up with questions on sports. The sports mentioned were listed on the board. Then students engaged in the following activity: (1) Researched on the Internet about the Top Sports in the World; (2) Read the information gathered; (3) Selected a superordinate root concept to start a CM; (4) Built a collaborative CM in pairs with at least 30 concepts covering the information read; (5) Presented the CM to classmates (Carrousel activity); and (6) Sent CM to teacher via email. The Carrousel activity (adapted from Lynch and Maclean (1994) apud Lynch and MacLean (2000)) consisted of pairs of two students, Students A and B, gathered in "stations" with their CM. While Student A would present the CM to each Student B visiting their "station", Student B would go round the other "stations" to listen to their classmates' presentation and ask at least 2 questions on their research. When Student B arrived back to his pair, then it was Student A's turn to visit his/her classmates "stations" to learn about their research and CMs. This task-repetition activity gave them invaluable oral and interactive practice. The guided repetition challenged them to be fluent and clear and also made them reflect and revise their own CM for the next presentation. It encouraged them to pay attention to grammatical accuracy, pronunciation and rhythm as well as to follow the order of delivery in order to be understood. It provided them with contextualised and meaningful practice and promoted self-confidence.

The 4 CMs produced were compiled and their layout can be visualised in Figure 5. Applying Buhmann & Kingsbury's (2015) global morphology classification, CMs A and B (at the top) can be considered Broad whereas C and D can be classified as Interconnected. All CMs included the Focus question (What are the top sports in the world?).

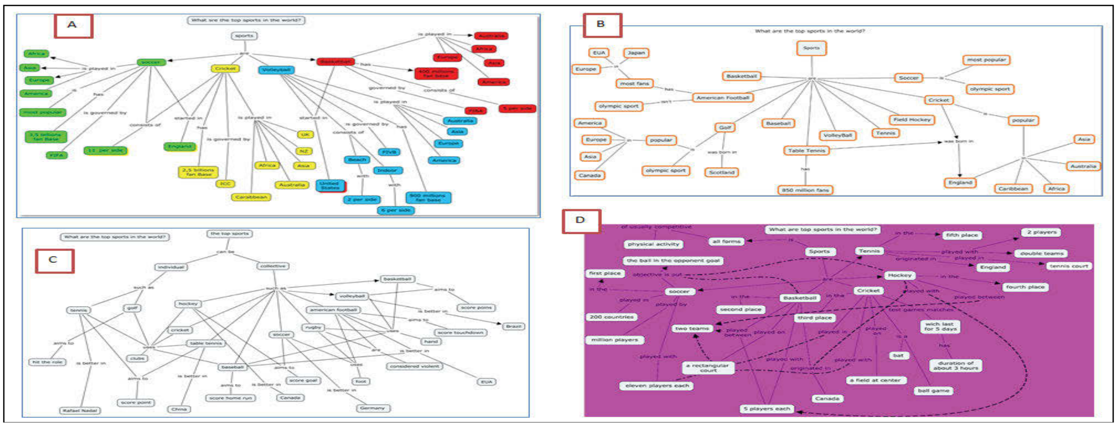

Figure 5. Layout of CMs A, B, C and D, produced by E2 students

To find out if at least 30 concepts were used (and which concepts were used), we activated the listing facility offered in CmapTools (Cañas et al, 2004) to list all concepts and linking words present in each CM and then compiled the lists into a table using Excel (Table 2).

	Mapa A		Mapa B		Mapa C		Mapa D	
	Conceitos	verbos	Conceitos	verbos	Conceitos	verbos	Conceitos	verbos
1	x per side (*4)	are	850 million fans	are	american football	aims to (*6)	2 players	are
2	x million / billions	consists of (*3)	Africa	has (*2)	baseball	are	200 countries	has
3	fan Base (*4)	(is) governed by (*4)	America	in (*3)	basketball	can be	5 players each	in the (*5)
4	Africa (*3)	has (*4)	American	is (*3)	Brazil	is better in	a field at centre	is
5	America (*3)	is	Football	isn't	Canada	(*6)	a rectangular court	is a
6	Asia (*4)	is played in (*4)	Asia (*2)	was	China	such as (*2)	all forms	~~objective is put~~
7	Australia (*3)	started in (*2)	Australia	born in	clubs	uses (*3)	ball game	~~of usually~~
8	Basketball	with (*2)	Baseball	(*2)	collective		basketball	~~competitive~~
9	Beach		Basketball		considered		bat	originated in
10	Carabbean		Canada		violent		Canada	(*2)
11	Cricket		Caribbean		cricket		cricket	played
12	England		cricket		EUA		double teams	between (*2)
13	Europe (*3)		England		foot		duration of about 3 hours	played by
14	FIBA		EUA		Germany		eleven players each	played in (*3)
15	FIFA		Europe (*2)		golf		England	played on (*2)
16	FIVB		field Hockey		hand		fifth place	played with
17	ICC		golf		hit the role		first place	(*5)
18	Indoor		Japan		hockey		fourth place	~~test games~~
19	most popular		most fans		individual		hockey	~~matches~~
20	NZ		most popular		Rafael Nadal		million players	
21	soccer		olympic sport		rugby		physical activity	
22	sports		(*3)		score goal		second place	
23	UK		popular (*2)		score home run		soccer	
24	United States		Scotland		score point (*2)		sports	
25	Volleyball		soccer		score touchdown		tennis	
26			sports		soccer		tennis court	
27			table tennis		table tennis		the ball in the opponent goal	
28			tennis		tennis		third place	
29			volleyBall		the top sports		two teams	
30					volleyball		which lasts for 5 days	

Table 2:What are the top sports in the world? – Concepts and Linking words used – E2

Table 2 provides rich data for reflexion. As can be observed, all 4 CMs had about 30 concepts, despite some repeated ones (of countries and continents) in Map A. This repetition of concepts lowers the informative power of Map A if compared to the other 3 CMs. As regards the linking words used, in Map B, 50% of the verbs used stem from the verb To Be, which weakens the content of the CM, especially if we compare it to Map D where the verb To Be makes up only 12.5% of the verbs used. Disregarding the 3 invalid linking phrases in Map D (objective is put, of usually competitive, test games matches) out of the remaining 87.5%, 71% involve the verb To Play which, followed by 5 different prepositions (between, by, in, on, with), conveyed distinct and appropriate meanings. The use of other verbs/phrasal verbs in the other CMs (consists of, is governed by, started in, was born in, aims to) and also of the comparative form (is better in) in Map C, could reveal a deeper understanding of the content in the Interconnected CMs as opposed to the Broad CMs. Some L2 students find it difficult to grasp how to use prepositions and phrasal verbs properly, so their voluntary selection and use in their Cmaps in this activity is significant in the promotion of meaningful learning.

Activity 13/E2 – Unit 4 – Focus on Grammar – Possessive Pronouns

Figure 6 presents the three types of pronouns: the subject pronouns, the object pronouns and the possessive pronouns, their explanation, use and examples. After its interactive presentation, students engaged in the following activities: (1) based on the skeleton map provided to them (not available in this paper), students had to tell us about themselves and about other 4 family members (using the concepts available in the Parking Lot or others); (2) they had to answer the following Focus questions: What are my family's (beloved) possessions? What are they like?; and finally, (3) based on the information in their CM, they were asked to write a narrative about their family's possessions.

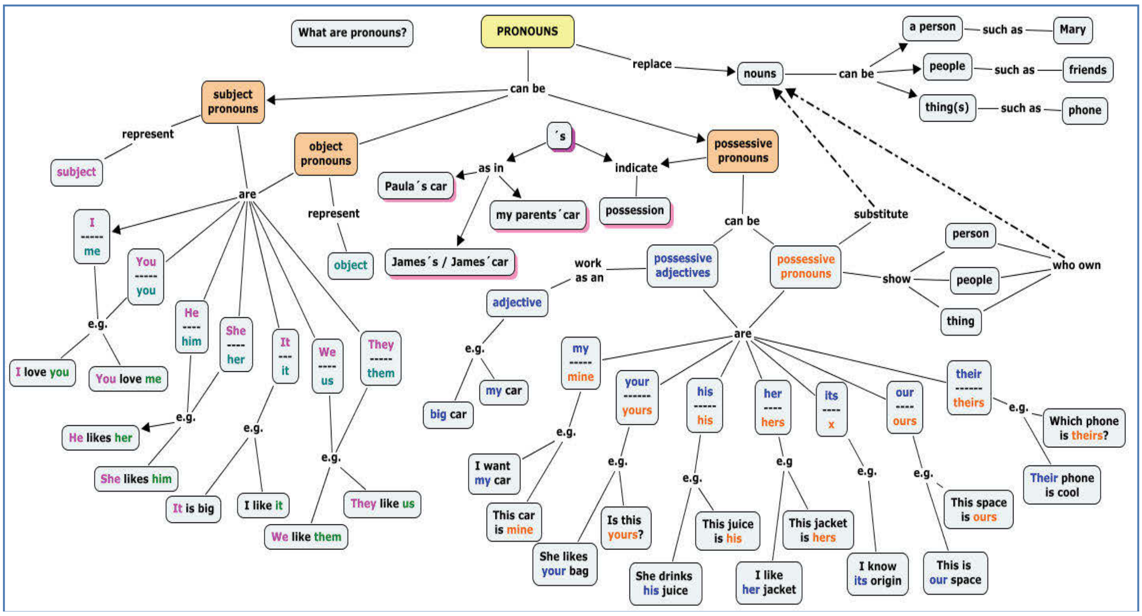

Figure 6. Pronouns: classification, explanation, use and examples – E2

The CM in Figure 7 was created by student E2-07. It reveals his family's possessions and qualifies them. Although the comparatives had not been studied yet, E2-07 felt the need to use them ([younger sister] and [older sister]) to talk about his family members. He was innovative in including the writing in the concept map, keeping everything together.

The inclusion of the comparatives (not usually covered in a Level 2 class) in a natural and contextualized way, expresses the non-linear and unpredictable potential of concept maps. The possibility to work with possessives and comparatives at the same time emerged in this activity with CMs. Practicing these two grammar items together could facilitate learning and promote meaningful learning. The non-linearity and unpredictability are attributes are used by Larsen-Freeman (1997) to explain the process of second language acquisition from a Chaos/Complexity perspective.

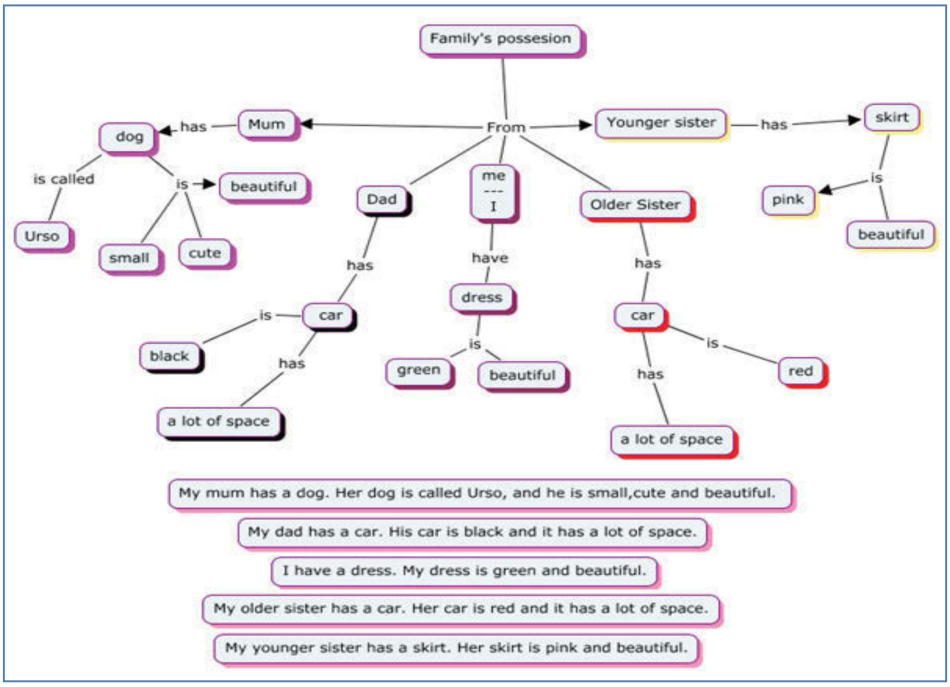

Figure 7. Family's possessions – E2-07

Activity 14/E2 – Assessment 2

For the final assessment, a piece of text with most possessive pronouns missing was used and students were asked to read the text and fill in the gaps appropriately. Then, students received the following instructions: (1) build a CM about the text read, choosing a superordinate concept to start the map; (2) answer these Focus questions: "How much do people love shoes? – How much do I love shoes?"; (3) include the information about the 4 people mentioned in the text; (4) include information about yourself and about your Mother to answer the Focus questions; and (5) after finishing the Cmap, write a narrative with the title "People's Passion about Shoes!" based on and using all information in the Cmap.

On assessment day, students worked on the first version of the Cmap (V1) and narrative. On the following class they received formative and summative feedback (via the FSA Table) from the teacher and worked on the second version of the Cmap (V2) and narrative. V1 built by E2-05 is presented in Figure 8 whereas V2 can be seen in Figure 9.

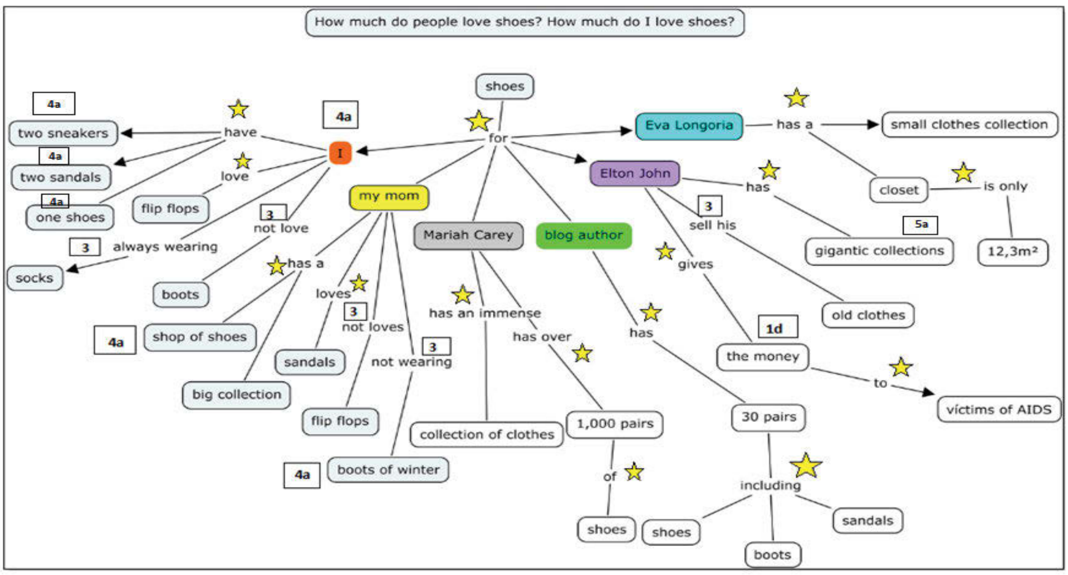

Figure 8. How much do people love shoes? –Final Assessment – E2-05, V1

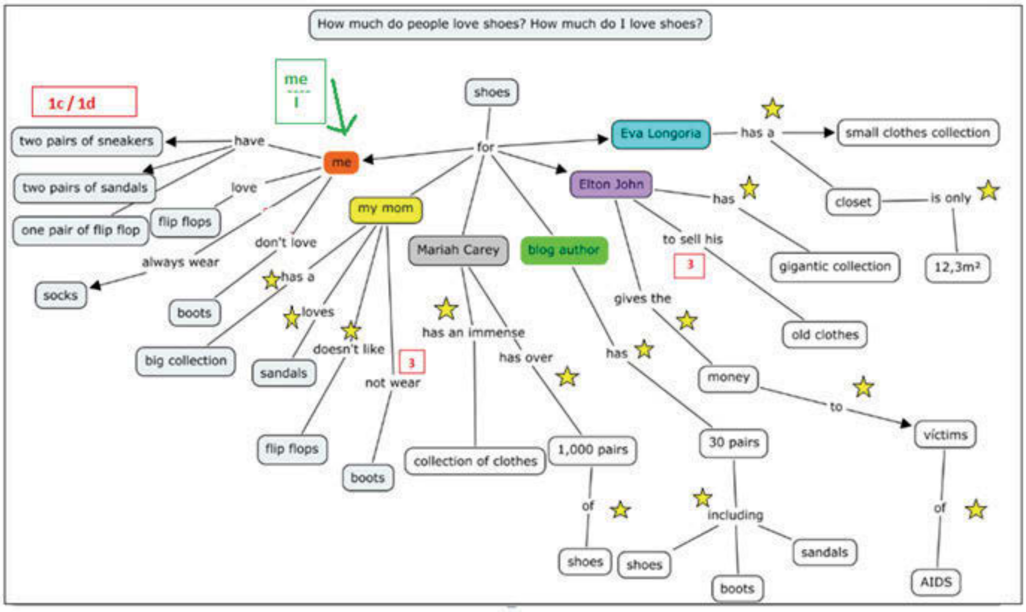

Figure 9. How much do people love shoes? –Final Assessment – E2-05, V2

Most ambiguities pointed out in V1 were worked on in V2, although some still occur (indicated in the boxes). As the student struggled with [I] and [me], the teacher offered the answer in V2. The act of reworking on the Cmaps and narratives encourage "noticing" (Larsen-Freeman, 2009) which can potentially contribute to promoting meaningful learning.

Activity 15/E2 –Oral Assessment

For the first time students were asked to plan an oral presentation using a CM. The Cmap could include any of the topics studied during the course, such as: sports; clothes; routine and temporary actions; the modal Can and the possessives. Students were provided with a Dialogue Plan (DP – not included in this paper) to serve as a basis to create their own dialogue.

Students E2-07 & E2-10 created their own DP (reproduced partially in Figure 9). A DP has 2 root concepts (which are the names of the 2 speakers) that are placed on the left and on the right-hand sides of the map. It does not necessarily answer a Focus question or provide the summary of a topic and it includes concepts that would normally be left out of a CM (such as "Hello" and "Good trip for you"), however, it plans speech in a hierarchical sequence and it is formed by propositions whenever the basic semantic unit is present ([concept] + linking word + [concept]). Looking at E2-07 & E2-10's DP in more detail, it is possible to observe that: (1) E2-07's utterances follow the usual written flow, from the left to the right, but E10's utterances are dragged from the right to start in the middle to then they flow back to the right; (2) students used a dash [-] as an initial concept to indicate a question; (3) students placed the verbs "says" and "asks" at the centre and at the top and bottom corners to be closer and more in line with the propositions they initiate; and (4) they took much care and attention to form appropriate propositions ([concept] + linking word + [concept]).

To assess the usefulness of a Dialogue Plan in the development of the aural skills and L2 acquisition, feedback was collected from the students right after the activity. Although one of the students did not see much difference between this type of planning to other types (E2-10), 3 of them stated that after finding it a bit confusing at first, it became easy to do and visualize and it was very good (E2-06, E2-05 and E2-04). The Dialogue Plan was found to be a form of CM that: "it is interesting ... it is better to visualize and locate where you are" (E2-07); "it helps to develop the dialogue, as all the dialogue structure is there, and also where you are going to add your personal information, which defines the difference between the dialogues, so I think it helps a lot and it is very useful" (E2-09); "it is easy" (E2-08); and "it is a very simple framework to understand how to speak" (E2-02).

Using a Dialogue Plan to plan and assist oral production can help ease the cognitive load on attention and working memory, as found by Lee (2013) regarding the use of a CM as a pre-writing activity. The dialogue structure and the spaces to add their personal information (E2-09) as well as the visual aspect (E2-05 and E2-07) may have helped and contributed to consider this a useful activity. As this activity was considered effective, simple and of easy visualization, it may have the potential to tap into students existing knowledge and promote meaningful learning.

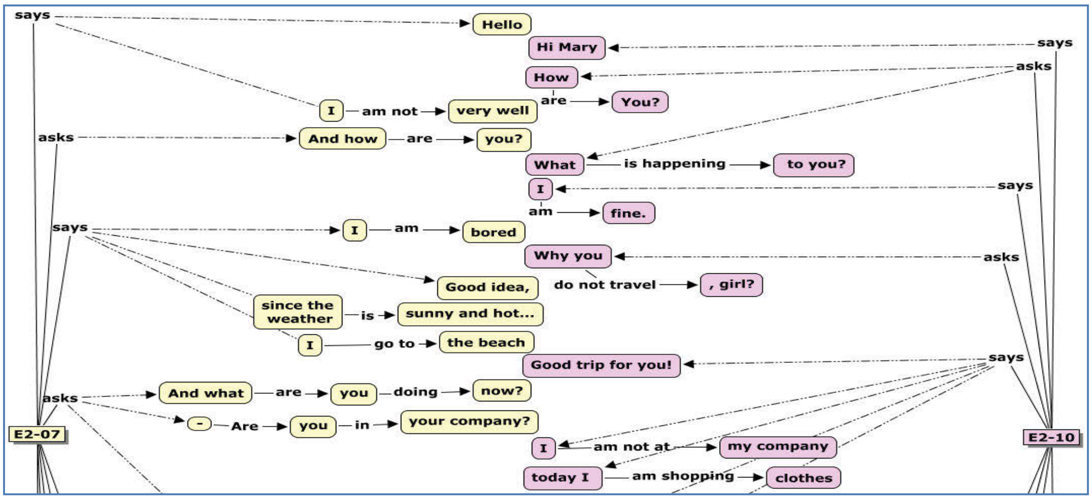

Figure 10. Oral Assessment - E2-07 & E2-10

4 Summary

With the support from all the research process which involved the review of literature, the creation and implementation of activities and the analysis of the feedback received in the questionnaire at the end of the course, the research findings revealed that Concept Maps can contribute to the development of L2 acquisition when: (1) CMs are used to assist with the learning and comprehension of the language; and (2) they are used to promote the learning of verbs, vocabulary and grammar. Our research data has also found that their visual aspect can contribute significantly with L2 acquisition and that students of all levels of proficiency in L2 can benefit from working with Concept Maps to develop their reading, writing and aural skills when learning a foreign language.

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CONCEPT MAPS AS SEMANTIC TOOLS FOR DEVELOPING SERVICES ONTOLOGY: THE DIGITAL LEARNING ECOSYSTEM OF SELECTED BASIC SCHOOLS IN GHANA

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Abstract. In this paper, we explored Cmaps tools as semantic tool for modeling services ontology. The designed services ontology served as probable determinant of schools' Digital Learning Ecosystem (DLEO). DLEO of seventeen (17) specially selected schools for this study, were mapped on the services ontology. The study showed that many services intended for schools are missing on the services ontology, thus causing school exhibit less enhanced DLEO. Nonetheless, some key digital practices were found in schools; and these were organised around 1) ICT classes and 2) use of Laptops/Smart devices in limited cases to facilitate learning. We propose to stakeholders in schools to use DLS ontology (Fig 3) to as guide to assess their schools DLEO; and carve out interventions to address the digital constraints.

1 Introduction

In this paper attempt is made to use of CmapTools (Cañas et al., 2004) to advance the digital services ontology to define the Digital Learning Ecosystem (DLEO) of schools. The term DLEO is a metaphor denoting the makeup of digital learning services (DLS) in the form of tools, resources, users, and prevailing socio-cultural and economic environments mutually functioning towards the fulfillment of an established educational goals(Laanpere, Pata, Normak, & Põldoja, 2014). We hold the view that various digital services inform the trend of technology integration and state schools' DLEO - in the form of complex relations in the system. That using the principles of concept mapping we will be able to obtain a visual representation of semantic relations of services as it occurs in the schools' DLEO. The use of Concept maps is traced to Novak, who developed the idea in the 1960s (Cañas et al., 2003; Novak & Cañas, 2007); he used it to obtain visual representation of a structured information in the field of learning. However, concept maps could originally be traced to Ausubel's theory of meaningful learning. The underlying principle of Ausubel's theory was that one's acquisition of new knowledge is contingent on what is already internalised by this individual (Novak, 2011). Novak applied the principles surrounding the theory to develop systematic knowledge building schema that supported and consolidated learning and knowledge acquisition (Novak & Cañas, 2007; Novak & Gowin, 1984). Today concept mapping has become a useful approach for developing knowledge; it is an effective means of supporting, collaborating and sharing knowledge in various fields of study. CmapTools, is the application for building concept maps. In the works of (Cañas et al., 2003) the effectiveness of the application in the context of education and training was documented. Among many other valuable uses, the tool supports concept-mapping integration, supports collaboration and sharing of concept maps. It offers visual representation of systematic representation concepts and patterns of linkages among concepts.

According to(Cañas et al., 2003), concept maps as tools facilitates knowledge structuring and representation. In addition, (Martin, 1994) defined concept maps as "two–dimensional representations of cognitive structures showing the hierarchies and the interconnections of concepts involved in a disciple or sub discipline." It is worth mentioning that concepts in the context of our discourse is explained as the perception held about regularity in event or record as so represented on the concept map by a label (Cañas et al., 2003). Deductions from the discourse of (Cañas et al., 2003; D. Jonassen, Carr, & Yueh, 1998; D. Jonassen & Marra, 1994; Tergan, 2005) point to the fact that complex inter-relations among cognitive structures can be modeled in the form of concepts maps. With this backdrop, we infer that one's ideas, knowledge and flow of thoughts could be visualised in the form of concept maps with the aid of CmapTools.

Though, literature holds it that there is no particular way to develop concept maps, a typical approach to building concept maps is advanced by (Cañas et al., 2003; Novak & Gowin, 1984). They suggested the following sequence of operation for building concept maps;

1. Set focus question
2. List important concepts
3. Order concepts in top-down structure and hierarchically
4. Link concepts with required proposition/descriptions
5. Cross link concepts for further elaboration
6. Review concept map for improvement

From the scholarly point of view, concept maps has the potential to promote meaningful learning, offer parameters for evaluation and setting standards for improvement – through systematically developed linkages between concepts, events and resultant outcomes or interpretations of events outcomes (Cañas et al., 2003; Novak & Gowin, 1984; Novak, 2011). To this end, this paper advances ontology of Digital Learning Services (DLS) defining an enhanced Digital Learning Ecosystem (DLEO) of basic schools in Ghana. An ontology is defined by (Noy & McGuinness, 2001) as *"a formal explicit description of concepts in a domain of discourses, and with the properties of each concept describing various features and attributes of the concepts and restrictions on slots***".** On his part, (Gruber, 1993) is of the view that knowledge can be represented formally in the form conceptualisation; and that the explicit specification of the conceptualisation of the body of knowledge would constitute an ontology. We deduce from this discourse and reviews (Amiel, Claudio, & Wives, 2016; Boyce & Pahl, 2007; Neumann, Finger, & Neumann, 2016) to make inferences that ontology is the representation of a view of a kind of knowledge system, inter-related events, or worlds, which represents a particular purpose within a particular domain. Thus, using CmapTools in our case we could develop a semantic relational of all DLS into a services ontology - to establish the status of schools' DLEO. Based on this premise, this paper reports the use of concept tools as semantic tools for designing services ontology for measuring schools' DLEO. The study was guided by two main objectives namely;

1. Build semantic relations of DLS items as probable ontology determinants of an enhanced DLEO
2. Apply concept maps as a semantic tool to establish schools' DLEO status.

2 Research Method and Approaches

2.1 Research Design and participants

A mixed design - qualitative and quantitative approach were used for the study. A structured rubric, which contained the indicators of the DLS were developed. It was meant to serve as the mapping grid for the qualitative data; which was used in measuring the state of the DLS in schools. We treated grid's data as quantitative measures of services in schools' DLEO.

2.2 Conceptual architecture

We advocated for a kind of enhanced DLEO based on the Digital Learning Services (DLs) ontology (Fig 1) that were organised in three layers/zones, namely; external, internal and transaction services. The external services are services provided by government and private institutions; adopted internally within schools' environment, and domesticated in the schools for use as transaction service; in the form of Infrastructure service, Learning Facilitation service and Change Management services (Jeladze & Pata, 2016; Quaicoe, Pata, & Jeladze, 2016).

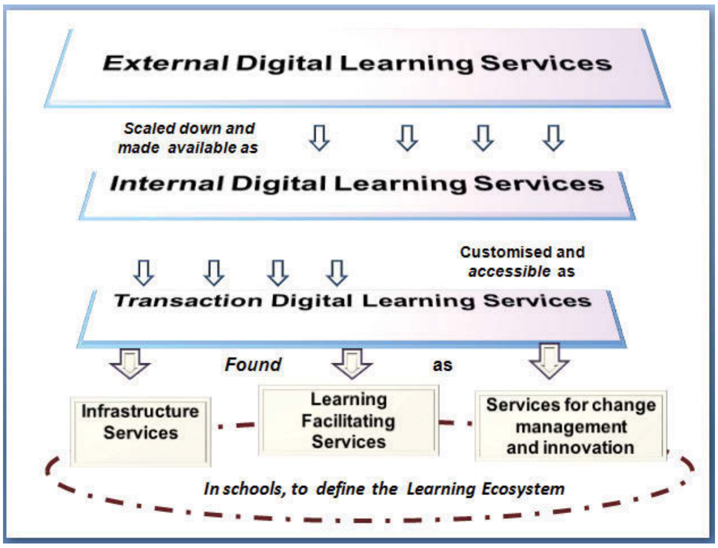

Figure 1. Initial conceptual architectural services ontology for schools.

2.3 *Data collection and inputs*

We devolved digital services rubrics, as grid on which qualitative data was mapped onto. The rubrics contained (205) services items grouped into three levels - external, internal and transaction; and further classified in the domain of infrastructure, learning facilitation and change management services. The qualitative data was obtained with various knowledge elicitation approaches. The approaches included interviewing Head teachers, ICT teachers and Circuit supervisors; focal group discussions, school observations, documents analysis, and video recordings of teaching and learning scenarios. The sources of the data were Seventeen (17) participation schools. The schools were selected were purposefully for the study from Sekondi-Takoradi Metropolis in Ghana; based on their locations. The locations were stratified into urban schools, peri-urban schools and rural schools.

2.4 *Tool(s)*

We used CmapTools for our ontology design. CmapTools, is an application for building concept maps. In the works of (Cañas et al., 2003), the effectiveness of the application in the context of education and training was identified; and found it relevant for our activity. Among many other valuable uses of CmapTools, it supports concept-mapping integration, supports collaboration and sharing of concept maps. It offers opportunity for visual representation of systematic hierarchy of concepts and patterns of linkages among concepts.

2.5 *Analysis*

On the rubrics for measuring, the DLS we used a binary scale to measure the status of digital services in schools per the grid data. We then computed the descriptive statistics of the services (see Tables 1, 2 and 3). Using the mean value of the services, we defined the status of the services activated within schools or otherwise; to inform comparisons to be made on the probable services ontology.

2.6 *Initial DLS ontology*

Using our services items relative to our conceptual architectural services ontology, we develop a schematic relation across all the services levels and classifications. We propose DLS ontology typified by inter-relation of equipment, tools, policies processes, and human actions that culminate into an enhanced DLEO for schools. We define the enhanced digital learning ecosystem of a school as system where digital learning services are adopted and used for learning engagements; which engagements is perceived as probable operations ("a" to "h");

a) Digital learning resources for educational communication,
b) Digital resources as tools for teaching non-ICT subjects,
c) Digital resources as tools for student learning engagement and assessment,
d) Digital resources for school management and administration,
e) Educational software and applications for innovative teaching and learning,
f) Use of free and open digital learning resources,
g) ICT classes for developing student digital competences and
h) Online/virtual environment for teacher - student-learning activities

Based on conceptual architecture (Fig 1), we propose our initial concept map as the probable outcome of the semantic relations defining ideal services ontology for defining schools' DELO (Fig 2, see appendix).

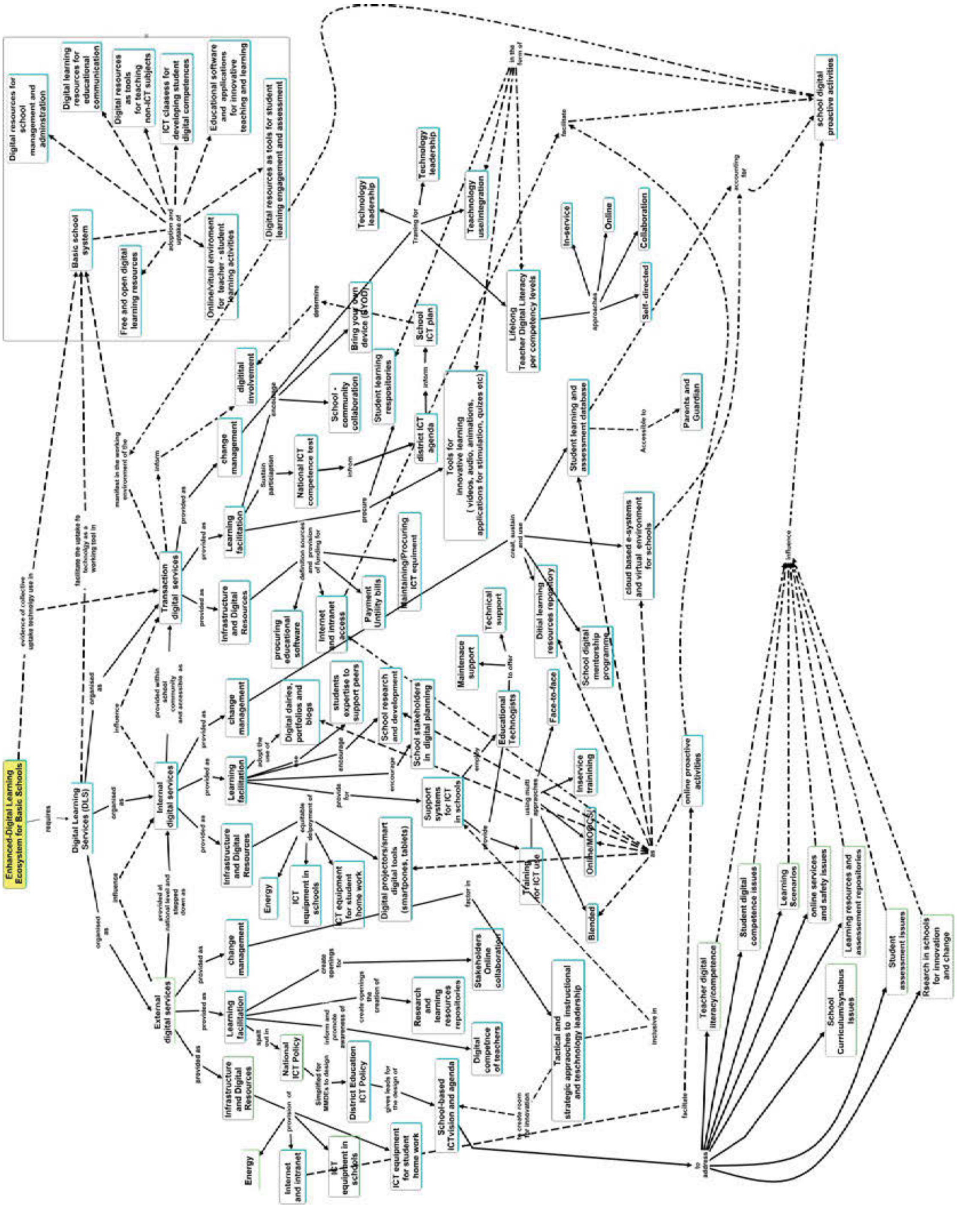

Figure 2. Conceptual representation of ideal DLS ontology for schools.

3 Results and Discussion

We extracted the DLS with relatively high means (M > .40) to represent the most prevalent services situation in the schools' DLEO. Tables 1, 2 and 3 show the descriptive analysis results of respective external, internal and transaction services; grouped as infrastructure, learning facilitation and change management services.

3.1 Infrastructure

External Services		Internal Services		Transaction services	
Service Group	***Service Items***	***Service Group***	***Service Items***	***Service Group***	***Service Items***
Infrastructure	*The electric power is permanently accessible to schools. (M = .88, SD = .332) *The government, municipality or /companies provide free ICT devices for individual teachers/students (M = .65, SD = .493) *Most of the students have ICT devices at home to do homework (M = .53, SD = .514).	**Infrastructure**	*The school uses has energy sources (electricity solar, wind, etc t power ICT devices (M = .88, SD = .332) *The ICT technology is located in fixed areas in the school (M = .41, SD = .507) *The school uses portable ICT technology (projectors, laptops, tablets, smart phones) (M = .71, SD = .47)	**Infrastructure**	*The school has to find resources and pay for having internet access (M = .71, SD = .47) *The teachers use internet with own devices and pay for it by themselves (M = 1.0, SD =.00) *The school has to find resources to buy devices for having wifi services in the school (M = .71, SD = .47) *The school is provided with the ICT technology for developing digital competences free of charge by the government/municipality/company (M = .41, SD = .507) *The school has to find resources for buying ICT technology they need for developing digital competences (M = .88, SD = .332) *The parents and teachers are responsible for buying ICT technology the students/teachers use in the class (M = .59, SD = .507)

Table 1: Descriptive statistics of infrastructure across the services.

Information from Table 1 shows that externally, some DLS in the form of infrastructure exist. These included electricity, access to ICT tools and equipment from either the government or the private institutions. As an internally service, the named external services were quite visible in schools. However, at the transaction services level, most of the schools were found wanting. One major setback in the schools DLEO was the absence of internet and wifi services. Almost all the schools had to grabble with the challenging of finding funding to provide effective ICT equipment, internet access, and payment of utilities bills. These factors constrained technology uptake in schools; as observed at the learning facilitation and change management practices within the schools.

3.2 Learning facilitation

In the analysis, it became evident that National ICT agenda/policy is put in place externally by the government (Table 2), School curriculum carved from the policy spells out procedures, method, and contents for teaching and assessing digital competences in schools. Internal services carved from external services were found in various forms of services in the school. For instance, ICT as a subject was taught in the schools; thus, students' digital competences are taught during computer classes and they participate in national ICT assessment for students. Services in schools however, were constrained by some factors – as alluded to in earlier discourse. Non-ICT teachers are unable to integrate technology due to lack of adequate resources and access to the internet. Again, the inability for system to have well-defined external services for teacher lifelong digital literacy training, definition of innovative learning scenarios and assessments, have translated into adverse digital services at the internal DLS level. For instance, none of the schools incorporated blogs, portfolio, and diaries among others in their learning activities. At the transaction services level schools lacked the capacity to be engaged in e-learning or online activities. They equally do not have digital repositories for assessment and learning resources; most computation of school based assessment (SBA) done manually. Our findings show schools seem to conducting learning activities more traditionally than using technology as supporting media.

External Services		Internal Services		Transaction services	
Service Group	***Service Items***	***Service Group***	***Service Items***	***Service Group***	***Service Items***
Learning facilitation	*MoE defines in the national curriculum the required learning outcomes for students' digital competences (M = .76, SD = .437). *National curriculum defines specific compulsory courses for learning digital competences (M = .65, SD = .493) *National curriculum defines the test- or exam-based evaluation for digital competences for students (M = .71, SD = .470). *National curriculum specifies learning ICT as a crosscutting theme to be taught by all subject teachers (M = .53, SD = .514). *National curriculum defines specific project courses where digital competences are integrated (M = .53, SD = .514) *MoE has set examples of student-centred assessment strategies and methodologies to schools in national curriculum (evidence-based, portfolio-based, progress-reporting, self-evaluation, peer-evaluation, self-testing) to be used in the teaching and learning (M = .53, SD = .514). *MOE or relevant national body defines quality criteria for digital learning scenarios (M = .41, SD = .507) *Private companies provide repositories of learning resources (M = .53, SD = .514) *MoE or relevant body provides free basic level trainings for digital competencies to teachers (internet, office tools - tools for creation and information literacy) (M = .47, SD = .514). *MoE/municipality/University/research groups collects data from the schools and analyses at national, regional, municipality level (M = .65, SD = .493).	**Learning facilitation**	*The school has computer class (es) (M = .88, SD = .332) *There is access to school's ICT technologies for work/lessons/homework when it is needed (M = .41, SD = .507) *The teachers voluntarily provide ICT support to other teachers about designing learning activities (M = .65, SD = .493) *The students' digital competences are taught in ICT lessons (M = .94, SD = .243) *The students' digital competences are tested (exam or test) (M = .94, SD = .243) *The students' digital competences are taught mainly by subject teachers (M = .82, SD = .393) *The students are required demonstrating ICT competences as part of the project work (M = .88, SD = .332) *The students in the schools collect digitally the learning-related evidences ((portfolio, diary, folder, blog etc)) (M = .53, .514) *The teachers provide in subject teaching digital learning activities that address factual knowledge (M = .59, SD = .507) *The students are taught mainly about how to use basic office software and internet (M = .88, SD = .332) *The teachers use in subject teaching digital learning activities that address problem-solving in socio-technical contexts (M = .41, .507) *The teachers use in subject teaching digital learning activities that address creativity and innovation (M = .65, SD = .493) *The teachers use in subject teaching collaborative digital learning activities (M = .47, SD = .514) *The teachers develop digital learning scenarios for their students (M = .53, SD = 514) *The teachers develop digital learning resources for their students (M = .65, SD = .493) *The teachers make use in their lessons of digital learning activities and -resources developed by other teachers (M = .59, SD = .507) *The teachers use in lessons simultaneously different digital activities/ resources to personalize and differentiate learning according to their students' needs (M = .59, SD = 507) *The school organizes digital learning process into the traditional lessons (M = .71, SD = .47) *The digital teaching process takes place mainly in the classrooms (M =.76, SD = .437) *The teaching with digital devices takes place mainly in the computer class (M = .88, SD = .332) *The school has some innovative ICT technologies for supporting learning (M = .47, SD = .514)	**Learning Facilitation**	*The school supports bringing own devices to lessons for learning digital competences (M = .76, SD = .437) *The school has to find resources to use the digital services for maintaining students' learning data (M = .76, SD = .437) *The school has to find resources for paying teachers/students access to the e-learning environments that are used for conducting lessons (M = .53, SD = .514) *The school has to find resources to buy the educational software or web services the teachers request for their lessons (M = .65, SD = .493) *The teachers in the school complement and accommodate the national curriculum and subject syllabi with additional digital learning outcomes and activities (M = .71, SD = .47) *The school participates in national exams/tests set by MoE to evaluate students' digital competences (M = .71, SD = .47) *The teachers share digital learning scenarios they created with other teachers digitally (school list, shared folders, shared school repository, teaching blogs) (M = .53, SD = .514) *The schools maintain externally shared activities with other teachers and schools through the circulation of digital teaching ideas and -resources between teachers and students (workshops, webinars, school visits, conference, networks, counselling etc.) (M = .47, SD = .514) *The teachers share digital learning resources they created with other teachers digitally (M = .71, SD = .47) *The school has to find resources to access to creative tools, games and various multi-media learning resources (Video clips, Audio files, Photos, Illustrations, Animated activities, Worksheets, Quizzes, Tests, Voting activities) (M = .71, SD = .47)

Table 2: Descriptive statistics of Learning facilitation indicators and activities across the services.

3.3 Change management

In the attempt to create and sustain any form of digitally enhanced learning environment in the schools, the dynamisms of technology in schools were taken into consideration. This dynamism fuels influence on innovation in schools. There change management services were deemed essential for managing innovation and stimulating it as well in schools. Table 3 shows prevailing change management practices in schools. Externally, regulations exist for data collection in schools for research and innovation purposes.

External Services		**Internal Services**		**Transaction services**	
Service Group	***Service Items***	***Service Group***	***Service items***	***Service Group***	***Items***
Change management	*The national accreditation of teacher professional levels accepts presenting digital development portfolios and evidences (M = .47, SD = .514) *MOE or relevant national body defines quality criteria for training teachers' digital competences (M = .41, SD = .507) *Private companies offer paid ICT courses for teachers that end with certificates, licenses (M = .65, SD = .493). *The subject- or practice-related professional online teachers' networks are active in the country (M = .41, SD = .507) *The subject- or practice-related professional online networks are active internationally (M = .65, SD = .495) *There is a national ICT agenda regulating digital competences, learning and innovation (M = .59, SD = .507) *MoE/Municipality sets regulations on purpose/frequency and methods on data collection in schools (M = .59, SD = .507)	**Change Management**	*Someone in school has paid tasks to manage ICT technology in the school systematically (M = .47, SD = .514) *The school has formalized ICT usage rules and regulations (M = .59, SD = .507) *Staff and students follow the ICT usage rules and regulations (M = .65, SD = .493) *The school has developed and maintains ICT vision and agenda(plan) (M = .71, Sd = .47) *The skilled students are recruited in mentoring teachers and other students about ICT usage (M = .41, SD = SD = .507) *Teachers plan and monitor their professional development using digital software (portfolios, diaries, blogs) (M = .41, SD = .507) *The teachers in the schools collect digitally their learning-related evidences (portfolio, diary, folder, blog etc) (M = .41, SD = .507) *The educational technologist provides in-school instructional support for teachers (couching, peer reviews, informal group meeting, workshop and etc.) to develop their digital competencies (M = .53, SD = .514) *The experienced teachers provide in-school instructional support for teachers (couching, peer reviews, informal group meeting, workshop and etc.) to develop their digital competencies (M = .47, SD = .514) *The educational technologist provides in-school instructional support for teachers (couching, peer reviews, informal group meeting, workshop and etc.) to introduce new approaches in digital teaching and learning process (M = .53, SD = .514) *The school uses practices to aid internally in the school the circulation of digital teaching ideas and -resources between teachers and students (open classes, peer-learning events, demonstrations, competitions etc.) (M = .41, SD = .507) *Teachers participate at basic level trainings for digital competencies (internet, office tools - tools for creation and information literacy) (M = .88, SD = .322) *School administrators, IT managers and educational technologists (or school teams) participate at trainings for school level digital innovation and organizational change (M = .65, SD = .493) *Subject teachers participate at trainings for teachers about subject related digital competencies (M = .59, SD = .507) *The school constrains teachers' professional learning to be relevant to the curriculum requirements and school strategy (M = .41, SD = .507) *The school plans ICT policy to contribute to the school's development strategy (M = .53, SD = .514) *The school leadership together with school community (board of trustees, teachers, students) plans for ICT policy (M = .59, SD = .507) *The new requirements for digital innovations are developed in the joint participation of leadership, It support, teachers, students and parents (M = .47, SD = .514) *School's ICT policy defines ICT contribution to the curriculum and the teaching and learning approaches with ICT (M = .71, SD = .47) *School's ICT policy defines digital devices, e-system and digital resource management, e-System utilization (M = .41, SD = .507) *School's ICT policy defines ICT utilization monitoring and evaluation, assessment and reporting,	**Change management**	*The school has to find resources for paying for IT support for maintaining school ICT technology (M = .82, SD = .393) *The teachers in the school consider some students' digital competence scales (ISTE framework, 21st skills framework or other similar) when developing subject syllabi and tasks (M = .47, SD = .514) *The teachers in the school consider some teachers' digital competence scales (ISTE framework, 21st skills framework or other similar) when planning their professional development (M = .71, SD = .47) *The teachers frequently participate in online professional networks about digital teaching innovations(M = .41, SD = .507)

			Monitoring and review of academic progress (M = .59, SD = .507) *School's ICT policy defines Staff professional development and training issues (M = .47, SD = .514) *School's ICT policy defines Internet safety issues, netiquette (M = .65, SD = .493) *School's ICT policy defines strategy for ICT implementation, Continuity and progression (M = .71, SD = .47) *The schools collect and analyzes data to monitor academic progress and make corrections (M = .71, SD = .47) *The schools collect and analyzes data to monitor organizational change and make corrections (M = .59, SD = .507) *The school collects and analyses data to coordinate teachers' professional development (M = .53, SD = .514) *The school follows privacy and safety regulations on digital data maintenance (M = .47, SD = .514)		

Table 3: Descriptive statistics of change management indicators and practices across Services.

Again, externally, teacher professional networking associations were found to be available either nationally or internationally. As an external DLS, national ICT agenda defines student and teacher ICT competences for digital literacy and innovation in schools. There are openings for teachers to acquire these digital competences from private organisations - as paid services. The external DLS seems to create digital opportunities directed towards the schools. Visit to schools revealed that school ICT agenda appear to be unwritten policy, which is adhered to based on prevailing school situations or learning scenarios. Stakeholders in school consider the undocumented school ICT policy/agenda as their guide. However, at the grassroots level these beliefs turnout not to be commanding compliance enough in schools. Teachers desired to be digitally literate and innovative yet various factors inhibit their prospects. Paramount is funding; funding digital learning practices in most of the schools is next to impossible. It is worth noting obstacle to generating innovation and change in schools is deeply rooted in the external DLS. For instance, externally(DLS) at the national level there appears to be no clear definition of what levels of digital or ICT competencies teachers require for their professional practice and development and practice. As observed, during teacher appraisal for promotion or managerial/administrative progression, evidence of digital literacy or competencies is not strong requirements. Teachers' digital diaries, portfolios, certification as evidenced of digital competence attainments is actually not a major requirement in teacher progression or professional practice. Therefore, the urgency for teachers to embrace the new professional paradigm of technology integration seems derailed; because practically, the system seems not appreciate the essence of this kind of school activity.

From the descriptive statistics of the services (Tables 1, 2 and 3) we modeled schools' DLEO on the services ontology, as presented in Fig 3 (see appendix). On the services ontology the opportunities and challenges resulting from the DLS are visualized. The opportunities across the DLS are the highlighted concepts; whiles, constraints as represented as concepts with broken lines around them. Other services with the potential to enhance schools' DLEO are also presented as concepts, but, with continuous borders and without highlights. Relying on the merits of CmapTools the semantic relation of the all the services we visualised in the form of Cmaps – depicting our service ontology. The status of schools' DLEO is mapped on the service ontology, based on the DLS performance in schools (Tables 1, 2 and 3). In the final analysis this study confirms a similar done with the same sample; that lack of various services capable of enhancing the DLEO of the schools constraints the schools from exhibiting proactive use of DLS(Quaicoe et al., 2016). In sum, schools require more support to pass the "digital service barometer" advanced as the services ontology from this study.

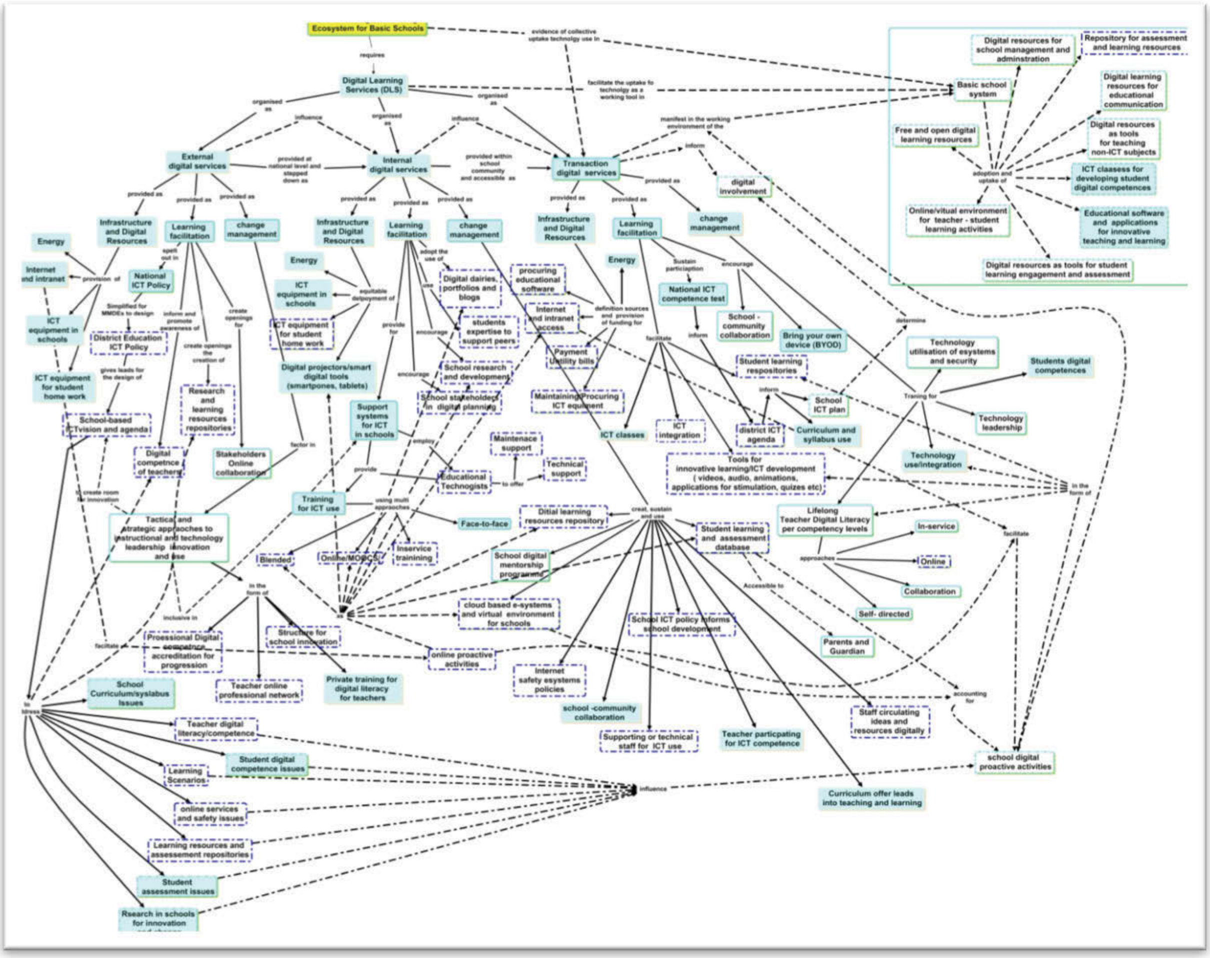

Figure 3. Schools DLEO as defined by the DLS ontology.

4 Conclusion

In this study, we used concept maps to develop DLS ontology. The results indicate that across schools generally lack structures for digitally enhanced activities. The overall outcome suggests that many services in schools are missing the services ontology; causing school not to exhibit an enhanced DLEO. However, the result indicates limited key digital practices in schools are take place: they are organsied around 1) ICT classes and 2) use of Laptops/Smart devices in limited cases to facilitate learning. We propose to stakeholders in charge of school development, to use DLS ontology (Fig 3) as guide to discuss the possibility of maximizing DLS in DLEO.

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CROWD IN, MAP OUT: CO-CREATIVE KNOWLEDGE BUILDING OF IGCSE MATH

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Abstract. The present study focuses on the process of learning to learn by conceptualizing and modeling systems. The learning experiment synthesizes several simultaneous learning goals, the bottommost layer being concept mapping basics, the second layer deepening the knowledge of the selected domain area, in this case of math, and the third layer, even if most implicit, the primus motor of the whole study, i.e. testing students' preparedness for UML modelling. As a design-based research (DBR) the target is to study the possibilities of educational improvement, in this case getting a better general view of math by concept mapping. The study traces the experiences and results of the concept map experiment carried out among 8th and 9th graders (N=25) of the Hope International School of Cambodia. The experiment started out by familiarizing the students with mapping principles and the IGCSE math syllabus, after which each group got two syllabus areas to prepare a presentation, a teaching video and a concept map. The map could be on paper or in electronic form. In the final state, the maps were combined as one poster that could be understood as a collective presentation of the domain knowledge i.e. one sort of visualization of the wisdom of the whole class. During the preparation of the map, the syllabus areas were used as a means to reflect one's own math path.
The study asks: "How does concept mapping suit learning math?", "What are the meanings that the teacher and the students give to this learning experiment?" and "How could concept mapping help in enhancing skills needed in ICT?" The results encourage using concept mapping in learning math to get a better overview: new concepts were learnt, linkages strengthened, and the syllabus content and order of learning various areas were reviewed more thoroughly. All this helps in depicting the IGCSE exam requirements as a whole. Most students regarded concept mapping as a beneficial tool for organizing their knowledge. With concept mapping not only math, but also learning-to-learn competence was enhanced, which should have a positive transfer effect on learning other subjects as well. However, more effort should be put into learning the orthodox expression of concept mapping.

1 Introduction

The need to understand the process of conceptualizing and to improve students' general study skills by using the possibilities of modern co-editing technologies is one of the driving forces of this study. As a kick start of a new topic, putting additional emphasis on learning the main concepts is essential. Clarifying the concepts and establishing a subject-based vocabulary is a good approach in any learning environment, but it is vitally important in multicultural learning environments. At international schools, for example, inadequate language skills and missing the core concepts set remarkable obstacles for learning. Allowing language minorities to form groups and build their own sub-cultures within the classroom hinders taking the scientific concepts into use. Instead, students will develop their own and alternative expressions to talk about matters, whereas the target is to be fluent with academic, and more specifically scientific social language (Scott et al., 2007; Leach & Scott 2002).

Embracing essential concepts paves the way for the next phase of linking them together and to previous knowledge. Not only inadequate concept possession but also misconceptions in associations create obstacles for learning. Maps may be used to deepen the learning by creating clearer and denser connections. At the same time possible misunderstandings are exposed. Currently, assessing is mainly based on the test results and activity during lessons. This may be adequate in the case of measuring success in reaching smaller learning objectives. In contrast, a more detailed development of conceptual understanding and getting a bigger picture is less frequently examined, especially in subjects such as math, where superficial learning by having only in situ problem solving strategies is common at the expense of a wider perspective.

Concept maps as visual representations of the schema enable grasping a bigger picture of the content and in this study maps are meant to be digested at one glance. In addition, individual nodes should be visually appealing and to contain images, even videos. Co-creativity and negotiations within groups are fostered by using state-of-art tools such as Prezi and Google Docs in a co-editing mode. It is not the tools alone but combining them and developing a teaching practice of conceptual learning using these tools that fit the task of getting a holistic view of the topic, in this case the whole IGCSE syllabus of extended math. Conceptualization is an essential skill also in ICT modelling, e.g. to communicate the overall component and class structure of a system when a new artifact is being implemented. This study notes the value of conceptualization not only in learning to learn, but paving the way for UML diagrams used in describing the architecture of ICT systems.

2 Maps and Videos make Meanings

The biggest difference between expert and novice thinking is the consistency and density of the underlying concept schemes. Deeper learning implies linking atomic details to create bigger and robust constructs by consciously tying new knowledge to relevant concepts and previous propositions that the students already possess, Ausubel (1962) defines this as meaningful learning. The denser and more connected this mental construction is, the better and more versatile knowledge structure a student has. For example, problem solving is based on the consistency of the concept map and the quality of its links and associations (Trowbridge & Wandersee, 1989). "Generic models" i.e. bigger scheme entities that enable experts to intuit in new situations are highlighted by Nersessian (1995). Lacking these models leaves novices puzzled and progressing with trial and error. Bransford et. al (2000) and Reif (1995) recommend the use of different kinds of graphical presentations, hierarchical charts and concept maps in teaching so that students may order concepts and organize knowledge. A good practice to organize and memorize reading content is to draw semantic summaries as concept maps and hereby engage in higher cognitive functions (Novak, 1984).

Concept maps represent a person's understanding in a hierarchical way, so that more general concepts are more to the top or center in the map, whereas subconcepts are lower or peripheral. However, the mapping syntax in this study regarding layout, linking (arcs) or concepts (nodes) is allowed to be loose in order to keep it as inclusive as possible. Moreover, no distinction between map types is made, and syntactically loose mindmaps are recognized alongside stricter concept maps, the orthodox use of which requires commutativity between the visual and verbal representations. According to concept map rules, nodes (concepts) must be connected with an arc (the verb), which then constructs a sentence: a subject - a predicate - an object. Hence, maps may be read, which Åhlberg (2002, 2005) states especially beneficial regarding learning. In general, elaboration with different representations supports learning.

The utility of multiple representations is not new, but has been pronounced in different theories, e.g. dual-coding by Paivio (1991), where imagens and logogens, in other words images and language, are handled differently in memory. Processing words is sequential, whereas images can be handled also simultaneously and in parallel, hence the processing speed of imagens overcomes logogens. Mandler (2014) has proved that memorizing images is easier, especially if the order of the items is not important, whereas remembering in sequence is advantageous in the verbal case. As exact sciences that consist of hierarchical concepts and relations, STEM subjects are especially fit for concept mapping.

In physics, Kurki-Suonio and Kurki-Suonio (2000) have presented a directed quantity map as the natural order of introducing quantities illustrated in Figure 1, where distance *s* is the first quantity, the change of distance as the function of time is the consecutive concept of velocity *v*, and finally the change of velocity as the function of time represented as acceleration *a*.

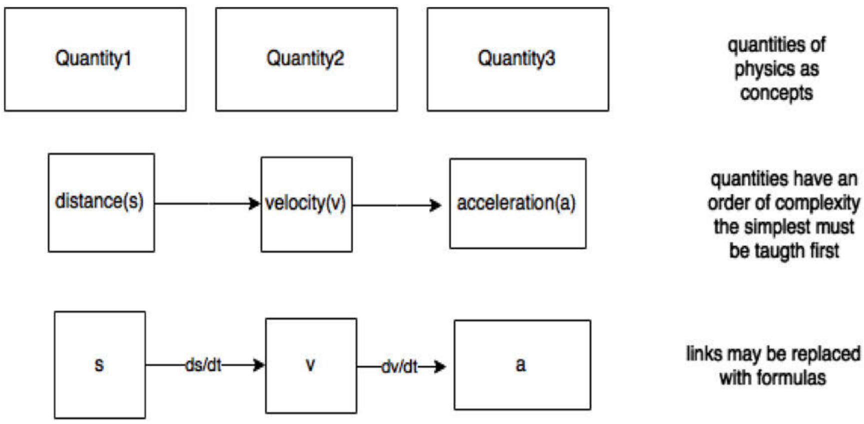

Figure 1. The directed quantity map dictating the order of teaching in physics.

The seven basic quantities of natural sciences include length (distance), mass, time, electric current, temperature, mass, and light intensity. Other quantities are derived from these by combining or elaborating the seven basic quantities. The linking verbs of the map may even be replaced with mathematical equations. The final directed graph is a representation of all the physics quantities and their relations (the fundamental laws of physics) and gives a sensible order of introducing new quantities.

In math, albeit a definite set of 7 base quantities does not exist, a path of developing numeric/algebraic thinking is well justified: e.g. in the number domain transferring from positive integers to negative, from which to rational and then irrational numbers by first calculating with four basic operations (add, subtract, divide, multiply) and then gradually expanding to more complex operations of powers and logarithms. In parallel, a paradigm shift of switching from numbers to letters and solving unknowns in functions is accomplished. Abstracting algebra is followed by a similar epistemology in geometry, emerging from 1D points and lines, through 2D shapes of triangles, squares, and circles to 3D shapes of pyramids, cubes and spheres, and their transformations.

The IGCSE math syllabus summarizes 11 subdomains of Number, Algebra, Functions, Geometry, Transformations and Vectors, Mensuration, Co-ordinate Geometry, Trigonometry, Sets, Probability, and Statistics (IGCSE syllabus, 2016). Instead of considering math as a trick collection of solving various problems we made an attempt of handling it as an academic subject that would benefit from a variety of elaboration mechanisms such as concept maps and preparing narratives in the form of digital stories. In this study, we would like to not only broaden the students' view regarding math as a subject, but also diversify the methods of learning it.

To provide the students with more opportunities for co-creation, this concept map intervention was enhanced with digital stories that in the context of education may be called pedagogical digital stories (Vivitsou et al., 2014). By negotiating over the manuscript, shooting and editing videos, the problem area will become more self-experienced, authentic and meaningful, which is an essential cornerstone of a more active and student-centered instructional set-up. Elaborating the theme as well as evaluating and selecting the best clips, enhance the progress to higher levels of Bloom's taxonomy of analysis, evaluation and creation. Climbing up the Bloom's taxonomy is considered a valid way of intensifying learning, for higher cognitive functions are involved.

3 Method

The teaching experiment was realized in the Hope International School of Cambodia with classes Year 8 (N=19) and Year 9 (N=6). The attempt was to familiarize students with the math syllabus and its concepts and ultimately construct an overview of the whole content. As DBR research the ultimate goal is to iteratively improve this learning artifact to provide meaningful modifications in math praxis, especially as regards creating an overview. The experiment included:

1. Scaffolded 'Functions' concept map, concept mapping principles explained
2. Taboo game with syllabus concepts
3. Syllabus read-through: sketchy mindmaps with and without the syllabus paper as a pair work
4. Presentations, one syllabus area per a group (Number, Mensuration, Probability, Algebra, Geometry)
5. Claymations of the same syllabus area
6. Scaffolded 'Trigonometry' concept map (<= the phase where Year 9 joined in)
7. The final concept maps of the current and next syllabus areas, electronic or paper
8. Reflection of one's own math path using syllabus area list
9. Poster
10. Survey

The IGCSE syllabus was split into 11 separate areas and the first area handled was 'Functions'. The exercise was included as a part of the test of the graphical solving. In the mapping exercise a student had to identify the main concepts based on the given text and build a map using these concepts. The teacher showed an example of constructing a map that is understood here as an expert skeleton map. The text was written to cover a short bullet list style of the actual syllabus, for in its entire conciseness it did not explain things clearly enough for the students to be capable of understanding the basic idea. Quite a few things in the syllabus were new to the students. To get the basic idea and gain more confidence in constructing concept maps the students went through the map instructions in teacher-directed style after getting their tests back. To give an example, the teacher showed how she would construct the map. After digesting the first bite the whole syllabus elephant was to be eaten. The first joyful practice of getting a grasp of syllabus concepts was playing the "Taboo" game. The player is not allowed to use the concept or its components while he is explaining it to his group by using different words. Symptomatically, the group of Korean girls struggled with the very basics, such as "subtract".

Next it was time to run through the whole syllabus, one colored paper per each syllabus area was filled with syllabus content and after that these papers were grouped so that closest relatives, such as Geometry and Coordinate Geometry, stood together. Each group selected one area for presentation, most of the presentations were PowerPoints (3) and one Prezi. The presentations were videoed and evaluated by other students. After the presentations the topic was further elaborated with Claymation, one of the groups selected Legos. The duration of the whole video was meant to be short, the recommendation was 30 seconds. Being able to squeeze up the essential is one of the key skills in modelling. However, the instruction aimed at creating as short clips as possible to make sharing and merging them easy. The ultimate goal in the beginning was to add videos to the final Prezi concept map of 11 different syllabus areas.

Another example, in this case Trigonometry, was shown and the topic was revised in general, when groups started to move back to concept mapping. In this phase Year 9 had completed their last topic, Trigonometry, and joined in. The remaining syllabus areas were distributed among groups. The students were advised to make the maps as presentable as possible i.e. visually appealing with lots of graphics and symmetricity, if that was easy to achieve. With the help of the syllabus, each student traversed his or her own math path from the very beginning and tried to recall the best learning experiences as well as strong and weak math areas. In the final phase, these individual concept maps were merged as one poster, and the survey was filled out.

In the following chapter, we focus on the analysis of data such as concept maps and digital stories that were produced during the process. In addition, also the qualitative data of surveys was used as a qualifier of how the process of getting the overview succeeded. In maps, we are interested in the terms applied; whether scientific or alternative concepts and how hierarchical and related the concepts were. It was supposed that the videos highlight the main concepts and demonstrate the mathematical rules and lemmas by oral means. The learning process that appears between the first and the last concept map as well as the meanings that the students give to the experiments are explicated.

4 Results

4.1 Sketches Scratch the Surface

In this learning experiment, a number of conceptualization exercises with various presentations and mapping techniques were used. The first syllabus read-through and resulting mindmaps demonstrated well-balanced but simplistic representations that exposed the common stereotypes connected with each domain, such as trees, dices and impertinent decorations (flowers). In visualizations, the students easily resorted to stereotypic hints, albeit in the later phase representations began to get more authentic (e.g. Algebra: Superman & Ironman), detailed and nuanced. However, knowing more also tempts the students to show off their skills causing the problem of excessive verbosity. In view of the poster, this was a problem, since only two of the final maps could be considered visually presentable and concise enough to be transferred to the poster. With the remaining maps, iteration rounds were necessary to simplify the end result.

The mindmap of JDYC group as an example of the collage type mindmap is quite consistently organized and justified. Some groups dedicated one paper to Math main concept, but here Math is missing and instead syllabus areas construct it as a whole according to IGCSE's definition. In the collage mindmaps arcs are implicit "consists of" links. To improve the inner logic of the JDYC map, Mensuration and Geometry could be swapped to get Geometry nearer to other geometric topics of Co-ordinate Geometry and Trigonometry, after which Mensuration and Algebra could also be swapped.

Regarding other groups, the SJEY set Transformations and Trigonometry close to each other, whereas DJ CHART Geometry and Coordinate Geometry, which is justified also based on naming. In many maps Algebra and Functions were positioned close to each other, as well as Sets, Statistics and Probability as one group. The Number domain was central almost in all the maps and it was used synonymously with the main concept of Math. The dominant position of Numbers demonstrates the number-centricity of mathematical understanding: students still lean heavily on the arithmetic calculation taught in the primary school. Counting with numbers is "real math", whereas algebra with variables (letters) is "artificial math".

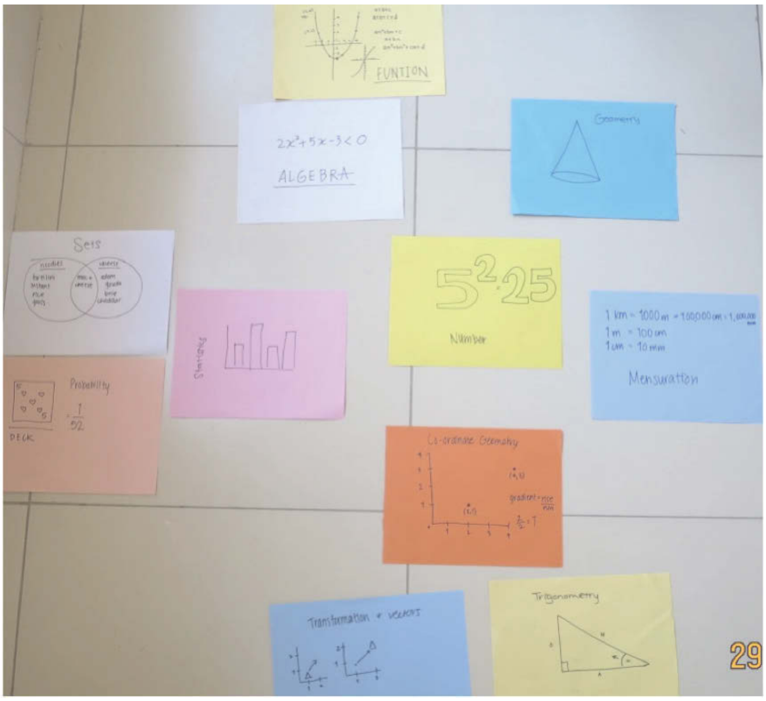

Figure 2. Math syllabus as a collage map (group: JDYC).

After drawing initial sketches with the syllabus paper readily at hand, the next task was to draw maps by heart that is considered reflecting students' mental models more faithfully. These maps started to include also emotions, such as math is "fun", "hard", "love" or "confusion" as in Figure 3.

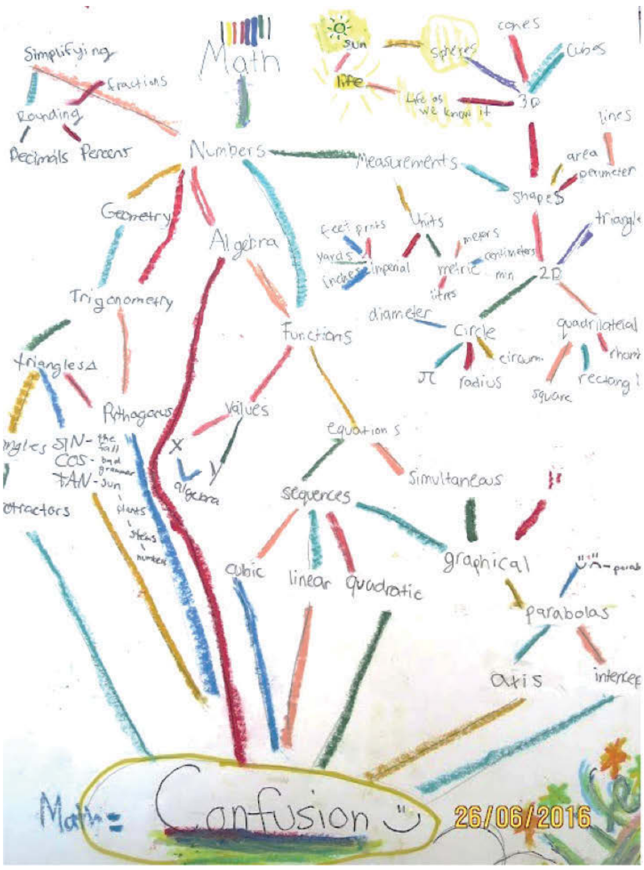

Figure 3. An example of a syllabus mindmap drawn by heart.

This map also manifests the increase in hierarchy levels, whereas most maps are still as flat as a Math central node and its direct children. The maps in Figure 4 exemplify this shallowness. In addition to the flat hierarchy, also inconsistencies in constructing the map indicate that conceptualization skills are still in their infancy. On the left, the syllabus areas of Numbers, Functions and Trigonometry are missing, but their subtopics are presented as the first level nodes. On the right, the map contains "Graph" as a child node, even if such a domain does not exist and the Graph node was found in other maps, too. This might reflect the division of the math mental model into numeric and graphical sections, but another sound and more probable rationale is the proximity of the last topic of Graphical Solving, which had been covered just before starting this learning experiment.

Figure 4. Mental model maps without hierarchy or consistency, Graph domain discovered right.

4.2 *Rolling in the Deep*

Gradually, the maps started to become more accurate and deeper in a hierarchy and more deliberately laid out, which demonstrates the development of conceptualization skills. The ultimate goal of this learning experiment was to get the syllabus poster constructed and for that purpose the individual domain maps should be as visual and concise as possible. An appropriate instruction could be the quotation claimed to be Einstein's, "Things should be made as simple as possible, but no simpler"; the accordingly constructed maps of Mensuration and Geometry in Figure 5.

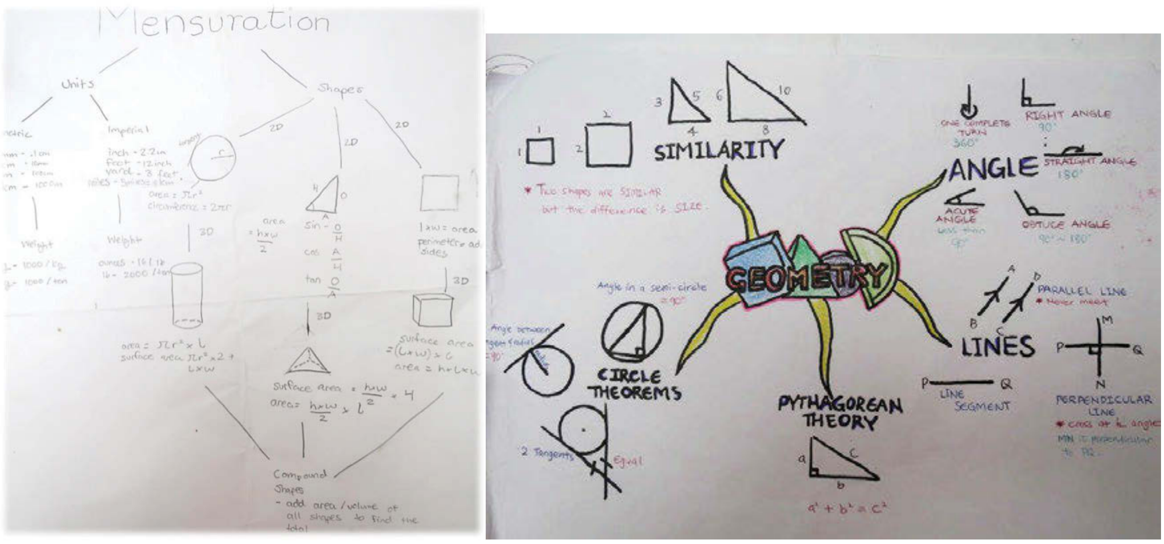

Figure 5. Examples of visually apt maps (groups: DJ CHART, Single Ladies) ready to be transferred to the poster.

Some groups got the conciseness requirement quickly as in Figure 5, whereas the Algebra map in Figure 6 demonstrated the 'knowing more' verbosity. Actually, as a test response the map would be an excellent answer, however, simplicity-wise it is too detailed and verbose. Further elaborations should be made with the mindset of designing a logo bearing in mind that symmetry and less text are valid means to increase harmony.

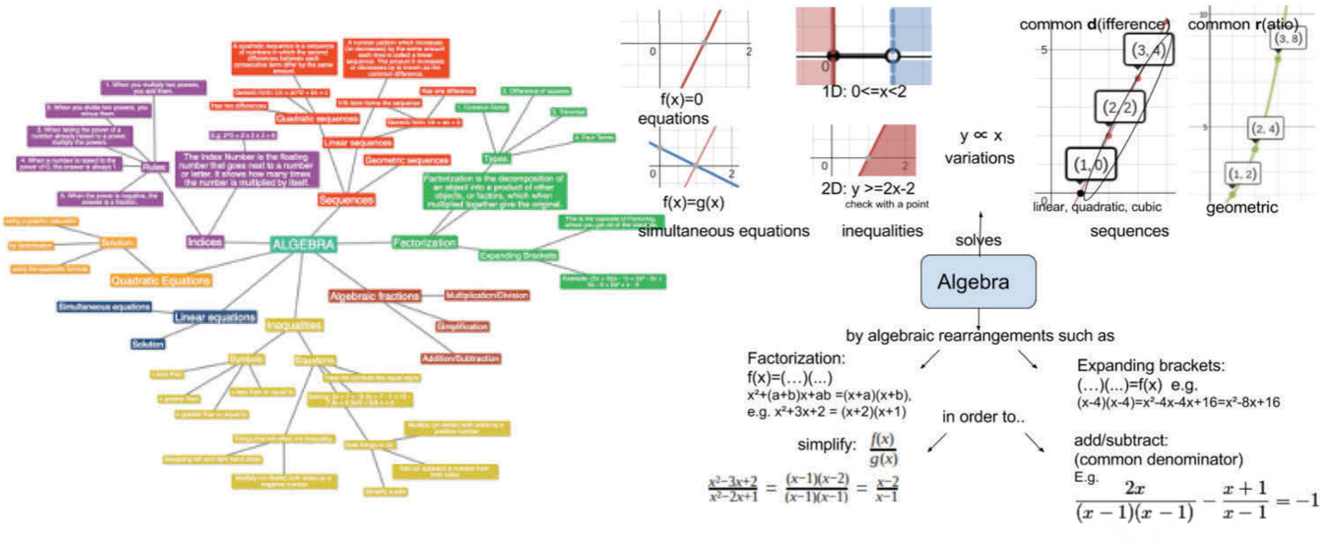

Figure 6. Squeezing and visualizing Algebra (group: SJEY).

Verbosity was reduced by iterating the map with the teacher, who gave visual hints; the next Algebra map drawn with the Google Drawings was then ready for the poster, the final version in Figure 6, on the right.

4.3 Claymation keeps Edutained

Claymation was obviously more fun for the students than mind mapping. The groups prepared videos with slow motion technique by merging images together. As a starter, a couple of claymation YouTube videos were watched. The examples contained only visual means played by clay characters, no audio and no text, which left some groups puzzled. In this way expression takes quite an abstract shape. Only one of the four videos (Geometry) was visual only and implementing syllabus subtopics as a fluent part of it proved almost insurmountable. Instead the edutainment values of the Algebra video with a clear background story were undisputable; the more bizarre its narrative, the more easily it will be remembered (see the screen capture of two heroic problem solvers in Figure 7).

Figure 7. Superman, Ironman and the Mystery of ‘x’ Missing Flowers.

The Probability video was more faithful to the given syllabus area and its subtopics and could be considered as a full revision of the area, thus profitable learning-wise. Fibonacci team picked up the exclusive but captivating theme of the golden ratio found in many visually appealing objects in nature. With clay, instead of fully internalizing and elaborating the syllabus domains, the students started to concentrate more on the visual appearance of their product and impressing their peers. Moreover, clay is quite slow as a material, which made some students move to Legos instead. In facilitating digital storytelling, Penttilä et al. (2014) argue that using a storyboard and closed instructions will catalyze the process; as an adjustment based on the outcome we would also recommend to have, if not a storyboard, at least fairly clear narrative as a starting point.

4.4 *Math Path of Nested Spirals, Numeric and Graphical*

The last reflective exercise, which was executed during the elaborations of the final maps, consisted of presenting the students' own math paths from the beginning of their school to the prevailing moment.

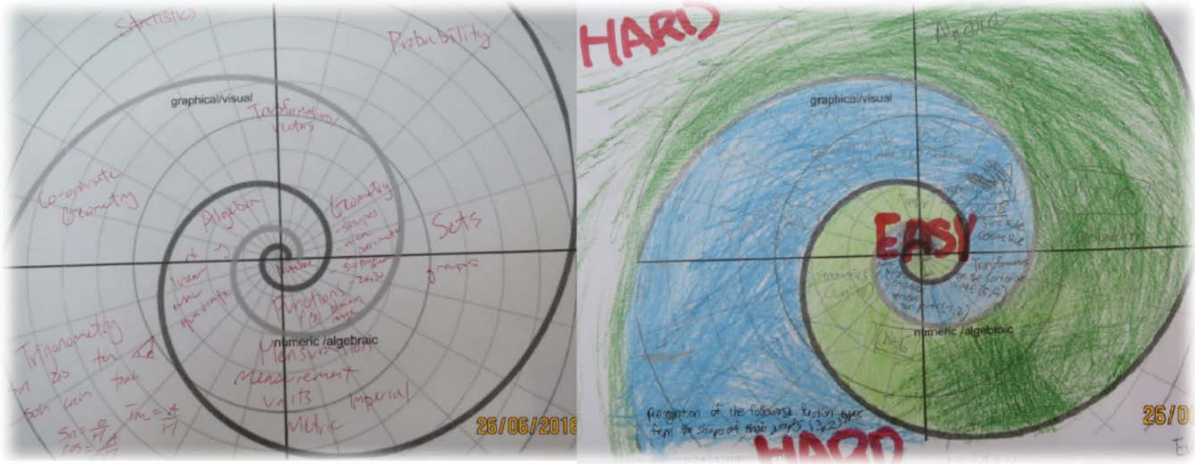

Figure 8. Spiral learning of IGCSE math.

The path was divided into two parts of numeric/algebraic and graphical/visual in order to give the students more structure for reflection. In Figure 8 on the left division is well justified, in the numeric path Number, Algebra, Mensuration, Sets, Probability and Statistics, in graphical Functions Geometry, Transformations, Co-ordinate Geometry and Trigonometry. Geometry starts in the primary school, however, the start of the graphical path with Functions is delayed till the beginning of formal operations that will take place in the middle school (Piaget & Duckworth, 1970). The order of Figure 8 is quite fit quickly reviewed, i.e. Number domain trains the concrete operations, where amounts and basic operations of adding and subtracting are natural starting points. Iterative additions may be streamlined as multiplication and division as its inverse are introduced. Dividing integers yields fractions. In addition to expanding Numbers, different Mensurations support the phase of concrete operations: geometric shapes and their lengths are measured and scaled from millis to kilos, time and money calculations are included. The algebraic paradigm shift of introducing functions and variables is made in the dawn of formal operations after the phase of concrete operations; functions begin to be visualized and solved by graphical means, hence in Figure 8 Algebra and Mensuration are to be swapped. The threshold of moving from arithmetic operations to algebraic is remarkable and often not without hardships. The threshold concepts of functions and variables are to be learnt properly in order to gracefully progress.

Alongside the subject knowledge, the math path exercise may be used to identify the bottlenecks of learning and shaping the student's math-id. This implies that there should also be enough time for reflecting the results, which we unfortunately did not have. In addition to instructed chronology, some students made the journey from Easy to Hard. This direction was not intended but interesting to take, exposing that Numbers and Statistics are considered Easy, Algebra and Functions Hard.

4.5 *Peaked in the Poster*

Year 8 and Year 9 cooperated in preparing the poster. Together we painted the background and produced the syllabus area transparencies. When they were put in their places, the chronological order was abandoned due to lack of space. Relevant and irrelevant decorations were added, e.g. Escher's graphic to illustrate transformations (translate-reflect-rotate-scale), Figure 9 the top and right middle edge.

Figure 9. The syllabus poster.

Completing the poster was running amok against the time and circumstances, but we were capable of finalizing it a day before the semester end. The participants were proud of the eduart achieved together; especially the input of Year 9 girls was crucial at this point and they also desired their effort to be recognized. The maps and other material were gathered and saved for further analysis and the students filled out the survey. One of the few negative comments was, “It can get repetitive and it’s not really that fun”. However, most of the students regarded concept mapping as a beneficial tool for organizing their knowledge, for example, “It is a creative way of showing how everything in math is related and how it all mixes”, “It was helpful because it was visual and it laid out the information nicely”, and “It helps me to organize the thoughts and ideas relating to the topic.”

5 Summary

How does concept mapping suit learning math? Based on the survey feedback concept mapping suits well also teaching mathematics, especially getting a better overview when revising. In general, study skills are worth investing in: information will cease and things tend to be easily forgotten, but study skills remain. Metacognitive skills refer to a student's awareness of his means of learning and allow him to plan good strategies for learning, which implies that a student possesses strategies to choose from, such as concept mapping. However, learning to learn should be a cross-curricular goal involving the entire academic field, not only math that is by nature rather exercise-based, practical and succinct in text, hence not the most obvious choice for mapping.

What are the meanings that the teacher and the students give to this learning experiment? The students were not acquainted with concept mapping beforehand, which caused some extra work in beginning, but familiarized themselves with the process quickly. If mapping is a new thing, it is good to spend some time to justify and motivate the experiment: the more positive the attitude, the better the student learns. As a motivational speech, the teacher revised her own education history in which concept mapping has had a significant role. The compact and visual expression of a concept map and consistency in constructing the knowledge resonated with her learning style and speeded up learning remarkably.

Similarly, the students in the present experiment viewed concept mapping very positively, acknowledging the value of the visual tool for organizing and associating things. Only three comments (3/25) could be interpreted mildly negative, speaking in favor of exercises as superior means over mapping, such as "For me doing problems in the book might help more" and "I think that solving many problems is the best way learn math - that solving many problems helps you to get familiar with the methods you are using." Indeed, concept mapping would complement, not substitute, exercises as the main means to learn.

As a reflective exercise 'My math path' was also promising, "It helped me review everything I know about math and go through the syllabus and organize what I need to know". The path may be used to improve the students' math self-concept and enable them to identify their own strengths and weaknesses; knowing one's weak spots reveals where to put more effort. As a consequence of all these elaborations one student granted, "I feel like becoming a better mathematician".

How could concept mapping help in enhancing skills needed in ICT? An ICT architect needs to model e.g. the components, behavior and interactions of a system. In industry, the de facto standard is unified modelling language (UML) analogical to concept mapping. However, UML is more restrictive. Two concepts must be connected with a specific link, whether inheritance, dependency, aggregation, containment, association or realization. The link type is indicated by selecting a proper arrow.

In this experiment, the mapping style was free, ranging from groupings with no lines to lines with and without describing verbs. With mindmaps degrees of freedom are numerous regarding connections and layout, which leads to the wide variety in an outcome. Mindmapping is creative, sometimes even comparable to the visual arts, but the creativity should be sacrificed in favor of knowledge building clarity, especially if the data is to be reused and refined further. Strict rules give freedom in follow-up and choosing between various visualization tools. In this experiment, the students' conceptualization skills developed towards more hierarchical and fine-grained structures, in which phase new rules may be brought into play. In this phase, introducing UML basics in ICT lessons would be beneficial. For example, cardinality and attributes provide the new options of focusing.

In general, the better defined and more exact the data is, the easier it is to convert it from one form to another. Usability of well-defined data may be exemplified with the difference of HTML and XHTML, where the validness and well formedness of XHTML enables tools such as schemas, validators and transformations. Moreover, propositions constructed as a triplet form (known as a turtle form in RDF) of a subject, a predicate and an object grants semantic web tools such as RDF visualizations. Visualizations are useful not only for teachers desiring more detailed methods of reviewing how their students think but also for the students themselves tracking their process of the knowledge building.

In this experiment, the students voted for a paper poster - doing with hands is the new black. The DBR research obliges reflective modifications to the learning artifact based on the feedback. In further research, we would realize the syllabus map in digital form and combine it with exercises, for instance, as links to exam papers from the map. The map should also merge all the project outcomes such as videos and presentations. Stored maps may complement traditional evaluation methods and be further elaborated as digital portfolios or digital learning journals that focus on the assessment of broader skills or competencies (National Education Association, 2012).

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DETERMINANDO EL NIVEL INICIAL DE LA COMPETENCIA DE TRABAJO EN EQUIPO CON MAPAS CONCEPTUALES: UNA EXPERIENCIA CON RADIO ESTUDIANTIL

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Resumen. Como parte de un estudio acerca de la aplicación de una estrategia didáctica basada en radio estudiantil y que se desarrolló en dos centros educativos de enseñanza media pública de Costa Rica, se utilizaron mapas conceptuales como instrumentos de medición y recopilación de información. Los participantes elaboraron mapas conceptuales durante las actividades iniciales de un taller de producción radiofónica estudiantil, en el que se aplicó la estrategia didáctica mencionada. Estos mapas fueron analizados para obtener una serie de conceptos clave, que a su vez permitieron establecer el nivel inicial de dominio de la competencia de trabajo en equipo, en los sujetos de estudio. Los resultados indican que es posible utilizar mapas conceptuales para valorar el nivel inicial de desempeño de competencias genéricas.

1 Introducción

Los mapas conceptuales han sido comprobados en la comunidad científica internacional como instrumentos de captura de información y conocimiento (Wheeldon, 2010; Wheeldon y Ahlberg, 2012; Baugh, McNallen y Frazelle, 2014). Tradicionalmente se les ha reconocido como organizadores gráficos, aunque existe un desarrollo académico muy importante en la perspectiva de herramienta para capturar datos y desde luego, organizarlos en un modelo de conocimiento. De igual manera, los mapas conceptuales han demostrado ser una herramienta valiosa en la investigación con métodos mixtos, como lo reporta Windsor (2013), e incluso son mencionados por Villa y Poblete (2011) como una de las técnicas o instrumentos con mayor valor añadido para evaluar competencias.

Debido a la eficacia de su aplicación en diversos campos del conocimiento, se decidió utilizar mapas conceptuales como parte de la metodología del proyecto de investigación *Análisis y asesoría académica de medios radiofónicos estudiantiles como espacios de aprendizaje*, desarrollado entre el 2012 y el 2014 en la Universidad de Costa Rica y que a su vez generó la tesis presentada por el autor para la Maestría en Educación del Instituto Tecnológico y de Estudios Superiores de Monterrey, México (Araya-Rivera, 2015). El objetivo del trabajo fue determinar si la estrategia didáctica de radio estudiantil permite desarrollar la competencia de trabajo en equipo en estudiantes de enseñanza media pública de Costa Rica.

A continuación, se describen los aspectos más relevantes de la investigación desarrollada, con énfasis en la aplicación de los mapas conceptuales como uno de los instrumentos de recopilación y análisis de información, que permitieron determinar el nivel inicial de desempeño de la competencia de trabajo en equipo que tenían los participantes de este estudio.

2 Referente conceptual

2.1 Radio estudiantil

La utilización de la radio como un espacio para enseñar y aprender ha sido evidente en los casos de las emisoras estudiantiles de Estados Unidos, Colombia, Venezuela, Argentina, Chile y México. En otros países también aparecen experiencias de emisoras estudiantiles que siguen esta orientación y tanto en Europa como en Estados Unidos, existen trabajos académicos sobre radios estudiantiles universitarias, entre los cuales se destacan los de Sauls (2001), quien valora de manera positiva el impacto de estos medios en la comunidad estudiantil.

En América Latina, Szyszko, Neri y Cataldi (2010) consideran que el uso de la radio por Internet y la elaboración de programas radiofónicos permiten abordar de manera más amplia los saberes incluidos en el currículum oficial, por lo cual el alumno puede estudiar los temas desde distintas perspectivas. Por su parte, Cárdenas (2008) asegura que la radio escolar es un híbrido entre la radio comunitaria y la radio educativa, con la cualidad de que es producida por niños y jóvenes en proceso de formación.

En el contexto costarricense, existen muy pocos trabajos académicos enfocados en el empleo de medios de comunicación como espacios de aprendizaje, o que en particular valoren el uso de la radio en los centros educativos. Una de las experiencias que se ha documentado, es la de Proyecto CONTRASTES, una comunidad de aprendizaje de la comunicación estudiantil con sede en la Universidad de Costa Rica y que tiene una permanencia de casi 25 años (Araya-Rivera, 2012a). En este proyecto participan estudiantes y profesionales jóvenes de distintas disciplinas universitarias, quienes de manera voluntaria diseñan, producen y publican distintos medios y espacios de comunicación, como programas de radio, un sitio web con servicios multimedia, una radio estudiantil digital y campañas de promoción de estos medios de comunicación.

Desde el 2009, Proyecto CONTRASTES también desarrolla un programa de formación y promoción en radio estudiantil en colegios públicos de Costa Rica, en el que han participado 14 centros educativos, en una actividad formativa enfocada en el diseño y el desarrollo de una emisora estudiantil. El propósito principal de esta iniciativa es promover la creación de una red nacional de radios estudiantiles en Costa Rica, que se constituyan en espacios de aprendizaje y de apoyo al currículum de la enseñanza secundaria pública del país. Aprovechando esta iniciativa, se planteó un proyecto de investigación en la Universidad de Costa Rica para identificar las experiencias de radio estudiantil en centros educativos, lo cual derivó en el trabajo de tesis para la Maestría en Educación del Instituto Tecnológico y de Estudios Superiores de Monterrey, que se reporta en este artículo.

En Estados Unidos y Europa, la radio estudiantil se conoce más como formato no comercial, dedicado a la transmisión de géneros musicales alternativos y programas elaborados por estudiantes. En este caso, es denominado *college radio* en Estados Unidos, *student radio* en Inglaterra y *campus* radio en el resto de Europa. A pesar de que en el ámbito latinoamericano se utiliza con mayor frecuencia el concepto de *radio escolar* para denominar a aquella emisora producida por alumnos de enseñanza primaria y secundaria (Araya Rivera, 2015), se estima pertinente destacar la característica principal de estos medios de comunicación (el diseño y la producción de programas por parte de estudiantes). Por esta razón, se utilizará el término *radio estudiantil* (como traducción al castellano de *"student radio"*), de manera que se formula la siguiente definición:

La radio estudiantil es un medio de comunicación radiofónica diseñado, gestionado y producido completamente por estudiantes voluntarios de un centro de enseñanza, con contenidos de interés para esta población, que constituye un espacio de experimentación y aprendizaje de la disciplina de la radio y la comunicación, y por lo tanto, en espacio de construcción del conocimiento. Por lo general, cuenta con una asesoría académica permanente, formal o no formal, desempeñada por una o más personas docentes del centro educativo, y cuya labor principal es la de aconsejar y dar continuidad a los procesos de formación, la gestión y la operación diaria del medio.

2.2 Aprendizaje por competencias

De acuerdo con Tobón (2013), el concepto de competencias se origina en el trabajo transdisciplinario, ya que para su definición requiere integrar las contribuciones de tantas disciplinas como se quiera abordar las diversas dimensiones del quehacer humano. Definir el concepto de competencia es una tarea de por sí compleja, considerando las distintas visiones de mundo (Galvani, 2006) y de enfoques (Poblete, 2006). Es así como en el marco de la Declaración de Bolonia de 1999, la Comisión Europea aprobó la ejecución de un proyecto piloto denominado Tuning Educational Structures in Europe, conocido como Proyecto Tuning. La iniciativa propuso comparar las estructuras y el contenido de los estudios superiores en los países europeos, con el fin de crear un área integrada de educación superior para Europa que permita comprender el significado de los títulos o las capacitaciones, y al mismo tiempo facilitar la movilidad de estudiantes y profesionales de un país a otro (González y Wagenaar, 2003).

Con base en los resultados de la investigación del Proyecto Tuning, la Universidad de Deusto, España, propuso un modelo de innovación que aplicó en una fase experimental en cinco de sus carreras o titulaciones en el periodo 2003 - 2004, y que fue sistematizado por Villa y Poblete (2007). Estos académicos entienden por competencia "el buen desempeño en contextos diversos y auténticos basado en la integración y activación de conocimientos, normas, técnicas, procedimientos, habilidades y destrezas, actitudes y valores" (pp.23-24).

En cuanto a la competencia de trabajo en equipo (en la cual se centró la investigación aquí reportada), se trata de una competencia genérica interpersonal y que Villa y Poblete definen como "Integrarse y colaborar de forma activa en la consecución de objetivos comunes con otras personas, áreas y organizaciones" (2007, p.244). Los autores enfatizan que, en la educación superior, el trabajo en equipo constituye una estrategia primordial para integrarse a cualquier colectivo humano, sobre todo en el ámbito profesional y laboral. En ese sentido, está estrechamente vinculada con casi todas las otras competencias genéricas, y en particular con las siguientes: pensamiento sistémico, pensamiento crítico, pensamiento colegiado, gestión del tiempo, resolución de problemas, comunicación verbal y escrita, comunicación interpersonal, adaptación al entorno, automotivación, innovación, espíritu emprendedor, gestión de proyectos, gestión de objetivos y liderazgo.

Dada la complejidad de la competencia de trabajo en equipo, Villa y Poblete (2007) consideran tres niveles de dominio:

- **Participar y colaborar activamente** en las tareas del equipo y fomentar la confianza, la cordialidad y la orientación a la tarea conjunta.

- **Contribuir en la consolidación y desarrollo del equipo**, favoreciendo la comunicación, el reparto equilibrado de tareas, el clima interno y la cohesión.

- **Dirigir grupos de trabajo**, asegurando la integración de los miembros y su orientación a un rendimiento elevado.

Para efectos de la investigación aquí reportada, estos tres niveles de dominio se sintetizaron respectivamente en participación activa y responsable, contribución al desarrollo del equipo y liderazgo.

3 Metodología

3.1 Enfoque, diseño, población y muestra

El estudio se realizó con un enfoque metodológico mixto, que combinó métodos cuantitativos y cualitativos para abordar el problema de investigación y con un diseño no experimental transeccional, de tipo secuencial exploratorio. La unidad de análisis correspondió a estudiantes de educación secundaria pública de Costa Rica y actividades de aprendizaje en las que se aplica la estrategia didáctica de radio estudiantil. Con respecto a la población del estudio, estuvo conformada por los estudiantes que participaron en las actividades de aprendizaje desarrolladas por el proyecto de investigación 212-B2-013 *Análisis y asesoría académica de medios radiofónicos estudiantiles*, llevado a cabo en la Universidad de Costa Rica en el 2014 y que estuvo a cargo del autor.

La población consistió en 27 estudiantes de dos centros de enseñanza media pública de Costa Rica, con edades entre los 12 y los 18 años, hombres y mujeres de clase socioeconómica baja y media-baja, y que cursan del 7° al 12° nivel de enseñanza secundaria, adolescentes residentes en las comunidades cercanas a dichos colegios y quienes participaron de forma voluntaria. Se optó por una muestra no probabilística definida por conveniencia, siguiendo los criterios indicados por Hernández, Fernández y Baptista (2010): capacidad operativa de recolección y análisis, entendimiento del fenómeno y naturaleza del fenómeno bajo análisis. Por lo tanto, se estableció una muestra de 22 personas que asistieron en las fechas en que se aplicaron los instrumentos de recolección de datos cualitativos y cuantitativos.

3.2 Mapas conceptuales como instrumento de medición

En la investigación se utilizaron cuatro instrumentos de medición: mapas conceptuales, una guía de observación, una rúbrica de autoevaluación y una rúbrica de coevaluación. En el presente trabajo, únicamente se mencionará la fase cualitativa del estudio que se caracterizó por el empleo de los mapas conceptuales, así como los resultados obtenidos con ellos.

Los mapas conceptuales permiten representar información mediante relaciones significativas que se muestran en una estructura de proposiciones, construidas a partir de conceptos (generalmente, sustantivos) unidos por medio de frases de enlace (verbos, artículos y preposiciones) (Araya-Rivera, 2012b). Estas proposiciones se vinculan entre sí para conformar unidades semánticas o de significado, de forma que integran una red de significados.

Los mapas conceptuales fueron propuestos a inicios de la década de 1970 por Joseph D. Novak y Bob Gowin, quienes se basaron en la teoría del aprendizaje significativo formulada entre 1963 y 1968 por el psicólogo educativo David Ausubel (Novak & Cañas, 2007). Así, durante más de 40 años los mapas conceptuales han sido valorados como una herramienta poderosa para la construcción, la gestión, la captura, el intercambio y la representación del conocimiento, pero en particular se aprecian como una buena manera de ayudar a un educador a organizar el conocimiento para su enseñanza, así como un buen recurso para que los estudiantes determinen los conceptos y principios clave de diversos materiales educativos (Novak, 1998).

Dadas las experiencias exitosas de su aplicación, ya reportadas en la literatura, se utilizaron mapas conceptuales como instrumento de medición del nivel inicial de desempeño de la competencia de trabajo en equipo en los participantes de este estudio. De esta manera, los estudiantes elaboraron mapas conceptuales durante las actividades iniciales de la estrategia didáctica y con base en sus reflexiones iniciales, determinaron conceptos clave y luego establecieron vinculaciones entre ellos, para formar proposiciones. A continuación, los participantes establecieron relaciones entre las proposiciones para representar redes de significados por medio de mapas conceptuales. Estas proposiciones fueron analizadas para identificar los conceptos clave y sus relaciones, con el fin de establecer el nivel inicial de desempeño de la competencia en estudio.

3.3 Aplicación de la estrategia didáctica y el instrumento de medición

La estrategia didáctica de radio estudiantil se aplicó por medio de un Taller de Producción Radiofónica Estudiantil, impartido por el investigador de este estudio con apoyo de estudiantes voluntarios del Proyecto CONTRASTES de la Universidad de Costa Rica. Algunos de los temas del taller fueron el lenguaje radiofónico, redacción y guion, programación radiofónica, planificación de la producción y opciones para la transmisión de la emisora estudiantil (Araya-Rivera, 2015). Esta actividad de aprendizaje tuvo una duración de 28 horas y consistió en 7 sesiones de 4 horas cada una, que se realizaron en los dos centros educativos participantes en el estudio, durante el segundo cuatrimestre de 2014. El proyecto final de este taller fue el diseño y transmisión de prueba de la radio estudiantil del colegio.

En cuanto a la aplicación de los mapas conceptuales, en la primera sesión del taller se realizó una actividad recreativa y de sensibilización hacia la competencia de trabajo en equipo, que también sirvió para que los participantes se presentaran. Esta actividad consistió en un juego con una pelota de cuerda que se iba pasando de persona a persona, de un extremo al otro del aula, de manera que se fuera creando una red entre todos los participantes (ver Figura 1). Cada persona se presentaba con su nombre y decía en una o dos palabras qué era para ella el trabajo en equipo. Una vez completada la red, se pidió a los participantes que salieran del aula con la red, sin que esta tocara el piso, por lo que debían organizarse ellos mismos para hacerlo. Para finalizar, se regresó al aula y se reflexionó con los estudiantes acerca de lo que habían hecho (cómo se habían organizado para salir, quiénes lideraron el proceso), y qué pensaban de esta actividad.

Los comentarios de los estudiantes fueron grabados en audio y se tomaron notas. Posteriormente, se comparó la red de cuerda con un mapa conceptual (como red de conocimiento) y se procedió a explicar la herramienta de los mapas conceptuales con una actividad colaborativa, en la que todo el grupo construyó un único mapa conceptual que respondiera la pregunta focal *"¿Qué necesitamos para hacer una radio estudiantil?"* (ver Figuras 2 y 3). A continuación, se les invitó a reflexionar sobre el proceso de construcción colaborativa, para luego solicitarles que se organizaran en equipos de tres personas, para elaborar mapas que contestaran la pregunta focal *"¿Qué entiendo por trabajo en equipo?"* (ver Figuras 4, 5 y 6).

Estos mapas fueron analizados para obtener una serie de conceptos clave que permitieron determinar el nivel inicial de desempeño de la competencia en estudio. Al promover la elaboración de los mapas en los propios estudiantes, se logra que los participantes demuestren de primera mano su percepción en torno a la competencia y a la vez se evita la contaminación del estudio que podría darse si el investigador sólo construyera estos mapas con base en las declaraciones de los sujetos. Así las cosas, los mapas conceptuales elaborados por los estudiantes se utilizaron para realizar la medición inicial del desempeño de la competencia en estudio. En la siguiente etapa de la investigación, se realizó la medición intermedia con una observación a los equipos de trabajo y en la sesión final se aplicaron rúbricas de autoevaluación y coevaluación, cuyos datos fueron procesados para determinar el nivel final de desempeño de la competencia y de la estrategia didáctica. Por último, los resultados obtenidos fueron triangulados para responder la pregunta de investigación.

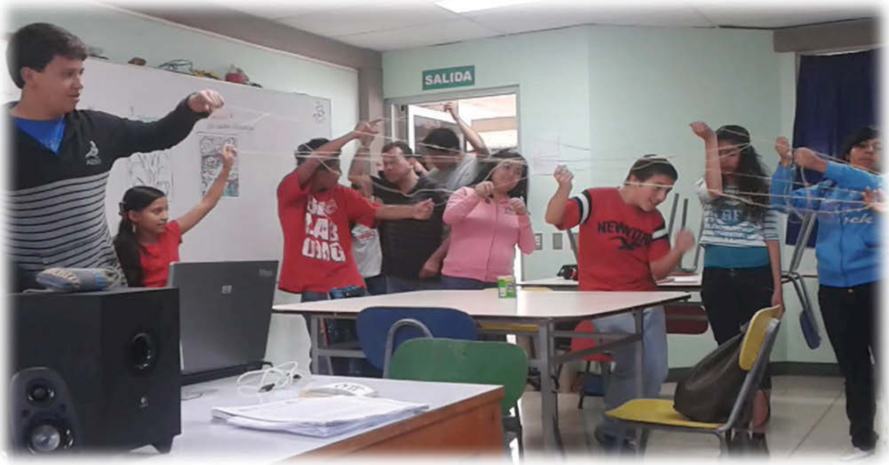

Figura 1. Estudiantes del Colegio 1 participan en actividad de sensibilización hacia el trabajo en equipo.

Figura 2. Estudiantes del Colegio 1 elaboran un mapa conceptual en forma colectiva.

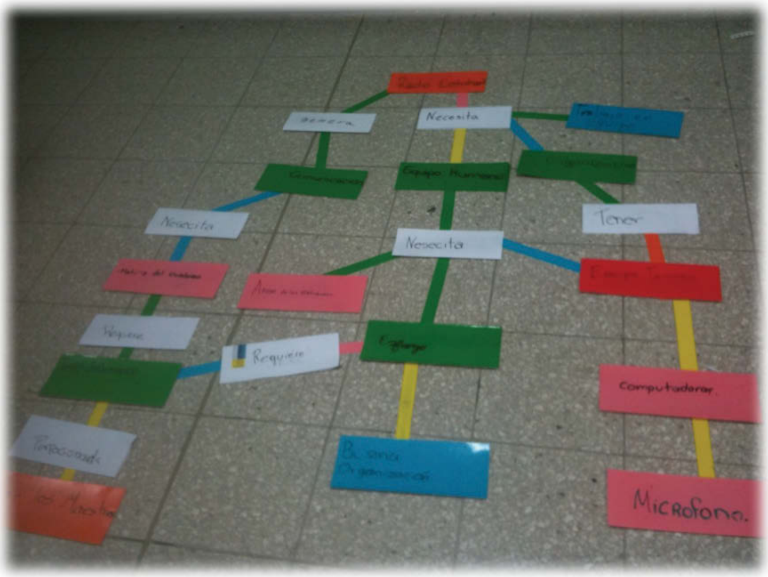

Figura 3. Mapa conceptual sobre el concepto de radio estudiantil, elaborado en forma colectiva por los estudiantes del Colegio 1.

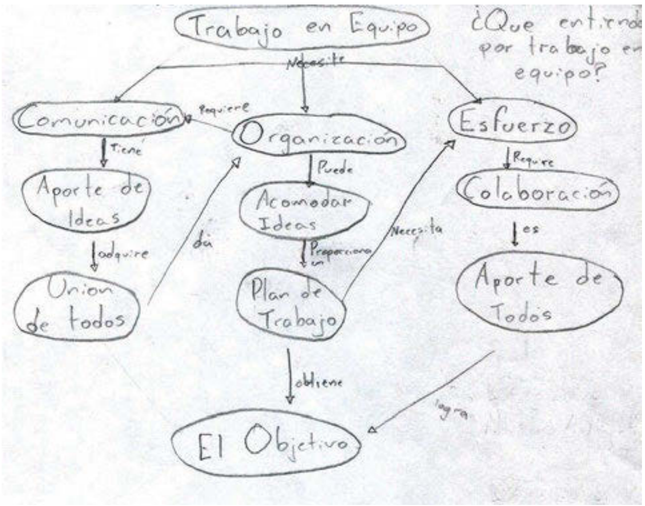

Figura 4. Mapa conceptual elaborado por estudiantes, Colegio 1.

Figura 5. Mapa conceptual elaborado por estudiantes, Colegio 1.

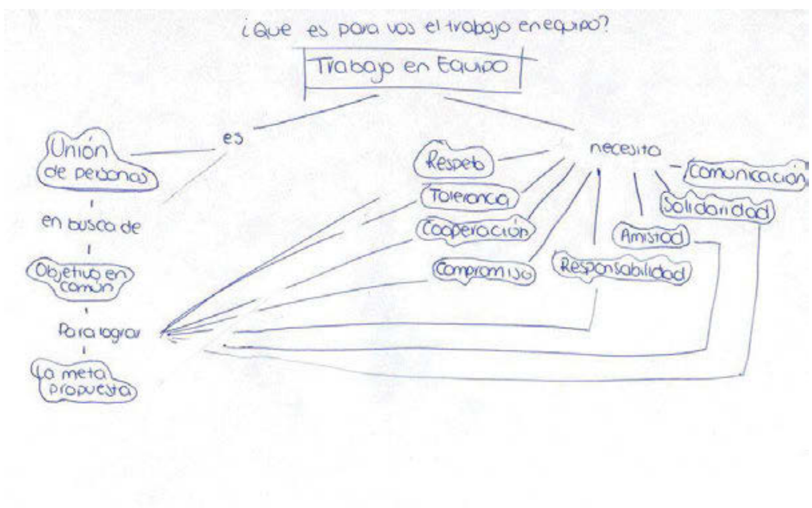

Figura 6. Mapa conceptual elaborado por estudiantes, Colegio 2.

4 Resultados y Discusión

4.1 Medición inicial del desempeño de la competencia, con mapas conceptuales

Como se indicó, la medición inicial se llevó a cabo en la primera sesión del Taller de Producción Radiofónica Estudiantil. Luego de la actividad inicial de sensibilización sobre la competencia, se elaboró el mapa colectivo en el que participó todo el grupo, y luego de reflexionar sobre lo realizado, se organizó la clase en equipos de tres personas para que elaboraran mapas grupales en torno a la pregunta focal *"¿Qué entiendo por trabajo en equipo?"* Con ello, se obtuvieron 10 mapas conceptuales, a razón de 5 por centro educativo. En ambas instituciones varios estudiantes afirmaron conocer la herramienta, aunque otros la desconocían por completo. Aunque las respuestas evidencian una percepción inicial de los consultados acerca del concepto de trabajo en equipo, al ser enunciados en los mapas, estos conceptos muestran también rasgos del desempeño de la competencia.

Con el propósito de sintetizar los conceptos principales expresados por los alumnos en sus mapas, el investigador elaboró un mapa conceptual que se muestra en la Figura 7. En este mapa se indica con uno o más asteriscos el número de veces que los estudiantes mencionaron cada concepto en sus mapas y se resaltó con letra negrita aquellos conceptos expresados con mayor frecuencia. Luego, se asignó un color a cada nivel de dominio y a su vez se marcó cada concepto con el color respectivo. Se indicó también una categoría "sin determinar" para aquellos conceptos que no pudieron ser relacionados directamente con alguno de los criterios de los tres niveles de dominio de la competencia.

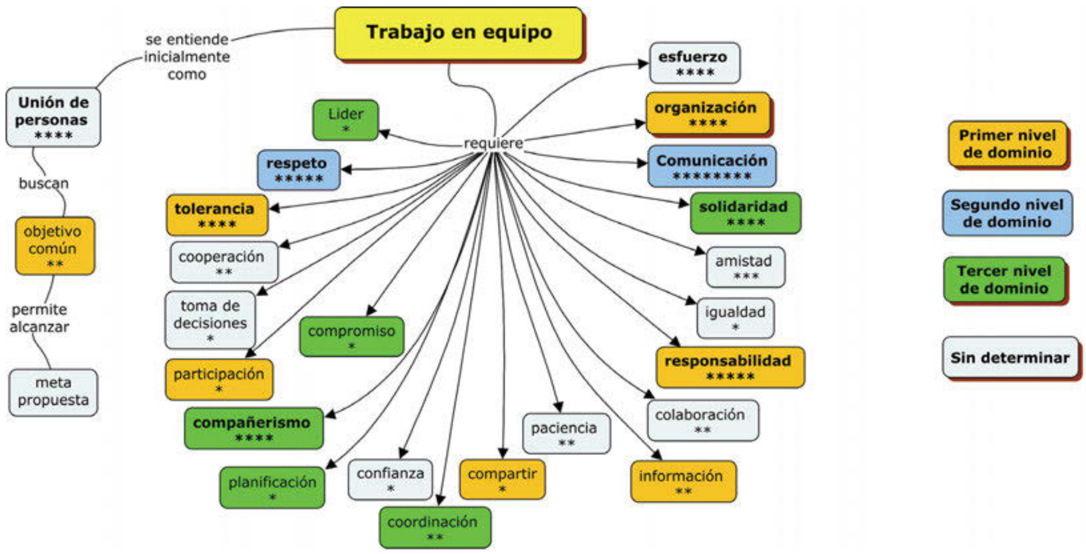

Figura 7. Conceptos iniciales acerca de trabajo en equipo, enunciados por los participantes (Araya-Rivera, 2015).

De esta forma, se tiene que los dos conceptos que aparecieron con mayor frecuencia en los mapas de los estudiantes fueron "comunicación" y "respeto", que están relacionados con el segundo nivel de dominio de la competencia de trabajo en equipo (contribución al desarrollo del equipo). En segundo lugar, aparecieron con mayor frecuencia los términos "solidaridad" y "compañerismo" que se relacionan con el tercer nivel de dominio (liderazgo). Por último, se aprecian los conceptos de "tolerancia" y "organización" que se identifican con el primer nivel de dominio de la competencia (participación activa y responsable), así como las ideas de "esfuerzo" y "unión de personas" que no están directamente vinculadas con alguno de los criterios.

4.2 Primer nivel de dominio de la competencia.

La participación activa y responsable de los estudiantes significa el punto de partida para el desarrollo de la competencia en estudio. Como se indicó anteriormente, en la medición inicial los consultados destacaron conceptos como la tolerancia y la organización, relacionados con el primer nivel de dominio de la competencia. Tal y como afirma Novak (1998), los mapas conceptuales permiten representar el conocimiento que tiene una persona, y en ese sentido es necesario destacar que los participantes lograron mostrar su comprensión inicial del concepto de trabajo en equipo. Por lo tanto, la frecuencia con que aparecen los términos en sus mapas conceptuales evidencia la importancia que los estudiantes dan a estos conceptos, lo que a su vez refleja su percepción inicial y rasgos del desempeño de la competencia en estudio, de previo a la aplicación de la estrategia didáctica.

4.3 Segundo nivel de dominio de la competencia.

La contribución al desarrollo del equipo requiere de interés, buscando el aprendizaje común entre los participantes. En la medición inicial efectuada con mapas conceptuales, los alumnos expresaron con mayor frecuencia los conceptos de comunicación y respeto, los cuales se relacionan directamente con este segundo nivel de dominio y que es necesario favorecer para consolidar al equipo, según lo expuesto por Villa y Poblete (2007).

4.4 Tercer nivel de dominio de la competencia.

El liderazgo requiere una comprensión del contexto, los recursos disponibles y los objetivos de la tarea asignada. Existe entonces la tendencia a creer que este nivel de dominio de la competencia sólo es desempeñado por una persona, "el líder", pero en realidad cada integrante del equipo ejerce algún grado de liderazgo en la realización de una tarea.

En la medición inicial, se determinó un predominio de los conceptos de solidaridad y compañerismo que están asociados con este nivel de dominio, y que guardan estrecha relación con el aspecto básico de motivación, destacado tanto por Villa y Poblete (2007) como por Salas, Burke y Cannon-Bowers (2000), entre otros autores.

5 Conclusiones

El primer hallazgo de esta investigación se refiere al concepto inicial de trabajo en equipo que tienen los estudiantes de secundaria y que está estrechamente relacionado con los tres niveles de dominio de la competencia. Al comienzo de la actividad de aprendizaje, los jóvenes consultados expresaron una serie de términos que fueron vinculados con los distintos niveles de dominio, con lo que se mostró la relevancia que tenían dichos términos en su vida estudiantil y por lo tanto, evidencian rasgos del desempeño de esta competencia.

Los mapas conceptuales elaborados por los estudiantes y utilizados en la medición inicial del desempeño de la competencia, presentaron un desarrollo muy básico a nivel conceptual y topológico, lo cual se entiende al ser la primera experiencia de este tipo para varios participantes, una situación que ya ha sido prevista en la literatura (Novak, 1998; Novak & Cañas, 2007; Araya-Rivera, 2012b). Sin embargo, la graficación realizada por medio del mapa conceptual de síntesis permitió al investigador apreciar cómo los distintos conceptos pueden asociarse a los criterios planteados por la literatura acerca de la competencia de trabajo en equipo, y en particular a los propuestos por Villa y Poblete (2007), que para los efectos de esta investigación se sistematizaron en participación activa y responsable, contribución al desarrollo del equipo y liderazgo.

Los conceptos de comunicación y respeto fueron los que tuvieron mayor presencia en los mapas conceptuales de los estudiantes y se relacionan directamente con el segundo nivel de dominio de la competencia, que es la contribución al desarrollo del equipo. Es interesante apreciar cómo los jóvenes manifestaron inicialmente un grado intermedio de desempeño del trabajo en equipo, que es producto de sus experiencias de vida.

Además, resulta particularmente valioso comprobar la observación de Villa y Poblete (2011) con respecto a que los mapas conceptuales contribuyen en la evaluación de competencias genéricas, pues, aunque podría pensarse que solo representan percepciones, también muestran en forma gráfica la construcción del conocimiento, que en buena parte se basa en la experiencia de las personas. Es así como los mapas de los estudiantes, a la vez que mostraron las ideas iniciales acerca del trabajo en equipo, también evidenciaron ciertos rasgos de desempeño de la competencia, ya fuera que hubieran tenido una buena o una mala experiencia al respecto. En este caso, lo pertinente es que hubo alguna experiencia relacionada con el trabajo en equipo y que fue graficada por medio del mapa conceptual.

En cuanto a algunas aplicaciones prácticas derivadas de manera directa de los hallazgos de la investigación, una primera recomendación se relaciona con el uso de los mapas conceptuales, que una vez más demostraron ser una herramienta poderosa que permitió potenciar el aprendizaje de los estudiantes. En ese sentido, los mapas podrían servir en futuros estudios para determinar los niveles inicial y final de desempeño de competencias genéricas y comparar ambos, de manera que pueda verificarse su grado de dominio en los estudiantes. Se recomienda su uso partiendo de la elaboración por parte de los alumnos, pues así es posible comprobar los rasgos de desempeño de la competencia en los jóvenes. Luego, es posible sistematizar la información con mapas conceptuales, como se mostró en la presente investigación.

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DISTINGUISHING KNOWLEDGE INTEGRATION GAINS IN EVOLUTION EDUCATION THROUGH CONCEPT MAP NETWORK ANALYSIS

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Abstract: Understanding how evolutionary changes happen requires connecting genotype and phenotype level concepts. This study uses a form of concept map, called Knowledge Integration Map (KIM), as a learning and assessment tool to support and assess connecting concepts within and across levels. KIMs visualize clusters and cross-links by dividing the drawing area into subject-specific spaces. A technology-enhanced curriculum on evolution has been developed and implemented in four high school science classrooms (number of students n=94). Pre- and posttests consisting of multiple choice items, short essays, and concept maps triangulated changes in students' integration of concepts related to evolution and their understanding of evolutionary changes of different organisms. Network analysis of concept maps identified changes in prominence of selected concepts and in cross-links between levels. Findings indicate that both low and high performing students made significant gains integrating concepts about the mechanisms of evolution. Results suggest that network analysis can be used to identify, compare, and track changes in concept maps over time.

1 Introduction

The theory of evolution is central to an integrated knowledge of biology (Thagard & Findlay, 2010) but teaching and learning evolution has been found difficult (Sinatra, Southerland, McConaughy, & Demastes, 2003). From a constructivist perspective, the theory of evolution is challenging to understand because learners can hold a wide variety of normative and non-normative concepts prior to formal instruction (Alters & Nelson, 2002). Many people show mixed reasoning using both normative and non-normative concepts of evolution (Evans 2005). From early childhood to adulthood, non-normative concepts are frequently used to explain why evolutionary changes happened (Shtulman 2006). Non-normative explanations often focus on the macro-level (phenotype) and fail connecting the underlying micro-level (genotype). Learners need scaffolded activities and tools to distinguish between non-normative and normative concepts and connect genotype and phenotype level concepts to explain how evolutionary changes happen. Connections between genotype and phenotype level concepts can be visualized through graphical representations, such as concept maps (Kinchin 2011). This study uses a biology-specific form of concept map, called Knowledge Integration Map (KIM) that distinguishes between genotype and phenotype level concepts and visualizes existing and missing connections between different levels (Schwendimann & Linn, 2015). This study explores KIMs as learning and assessment tools to support and distinguish learning gains through network analysis.

2 Methods

A technology-enhanced week-long unit on evolution, using human lactose intolerance as a case study, has been developed for this study and implemented in authentic science classrooms delivered through the online inquiry learning environment WISE (Linn, Clark, & Slotta, 2003). Guided by the knowledge integration (KI) pattern (Linn & Eylon, 2011), the WISE unit for this study was designed to elucidate the mechanisms (How do evolutionary changes happen? To whom do evolutionary changes happen?) of evolution. The knowledge integration pattern assumes that learners can hold multiple, often contradictory concepts of scientific phenomena and that learners can distinguish and make connections between new and existing concepts. Instruction guided by the KI pattern thus emphasizes eliciting existing alternative concepts (so that they can be inspected and considered), adding new normative concepts to the repertoire, helping students to build a set of criteria for distinguishing alternative concepts (for example through scaffolded inquiry activities), and encouraging students to sort out alternative concepts. According to the KI pattern view, learners need carefully designed instruction that makes new concepts accessible and guides them to revisit and distinguish alternative concepts, especially for complex and challenging topics such as evolution.

3 Curriculum Design

This study used human lactose intolerance as a case study that illustrates the mechanisms of evolutionary changes in a human context. Human lactose intolerance can illustrate the mechanisms of evolution [mechanisms] through changes in the production of the enzyme lactase. Building an integrated understanding of the theory of evolution requires learning how traits change (sources of variation), get selected (selection of variation), and are passed on to offspring (inheritance) [mechanisms]. Understanding the mechanisms of evolutionary change is challenging because the modern theory of evolution consists of a complex network of concepts from different fields of science (for example genetics, cell biology, and population biology) and different levels (for example genotype and phenotype) (Duncan & Reiser, 2007). Research suggests that students have difficulties connecting concepts across different levels (Duncan & Tseng, 2011). Especially the genotype-phenotype duality is unique to biology and is fundamental to the understanding of heredity and development of organisms (Mayr, 1988). Genotype level concepts describe the genetic material and its variations over time due to random mutations and recombination. Phenotype level concepts refer to the expressed physical form of an organism that results from the genotype and environmental influences. The interplay between sources of random variation (genotype level) and selection (phenotype level) forms the basic understanding how changes get passed on to offspring (inheritance), which over time influences allele frequencies in the gene pool (Dawkins, 1976). Lacking integration of genotype and phenotype level concepts can be a major hindrance to understanding evolution (White, Heidemann, & Smith, 2013). A stronger integration of concepts related to evolution on the genotype-level (sources of variation) and phenotype-level (selection of variation) is expected to strengthen more frequent usage of normative concepts (such as 'mutation') and decrease the use of non-normative concepts.

3.1 Procedure

Human lactose tolerance served as the case study for a weeklong inquiry-driven evolution unit, called 'Gene Pool Explorer', delivered through the web-based inquiry-learning environment (WISE). The unit began with a short outline by the teacher followed by an introduction to the basic techniques of concept mapping. Students practiced generating concept maps in a task using an everyday example ("What does it take to have a pizza delivered?").

Pretest: This study used a pretest-posttest design to measure students' prior knowledge and track changes in students' integration of evolution-relevant concepts. Both tests were delivered through the WISE platform. Students individually filled out the pretest and completed a concept mapping task (see pretest-posttest construction below) on the first day of the unit. Immediately after finishing the unit, students completed a posttest (identical to the pretest) and a posttest concept map activity.

Unit activities: The WISE 'Gene Pool Explorer' unit consisted of six activities. Each activity included texts with photos or videos followed by several automatically graded multiple choice items as well as short essay questions for which the teacher provided feedback by the next day. The teacher randomly grouped students in each class into dyads. Each dyad shared one computer and worked at its own pace.

This paper will focus on analysis of pretest-posttest differences. Analysis of embedded concept mapping activities will be reported separately.

3.2 Participants

The WISE unit 'Gene Pool Explorer' was implemented in four general biology classes in a high school with an ethnically and socio-economically diverse student population of 9th and 10th grade science students. The high school had an enrolment of around 2000 students and was located in the urban fringe of a large US city. School-wide, 12% of students received free or reduced price meals; four percent of students were classified as English Learners; 67% were White, 16% were Hispanic or Latino, 10% were Asian, and 3% were Black. All students were familiar with technology-enhanced learning environments and a few had used other WISE units before. Only students who completed pretest, posttest, the WISE unit, and the concept map activities were included in the analysis (total n=115; included in study n=94). No student opted out of participating in the study. Students spent six hours over one week (two separate 50-minutes and two double periods) to complete the unit. Throughout the unit, the teacher and a researcher provided support for technical and content-specific questions. Prior to implementation, the unit has been reviewed by teachers, students, and biology experts to evaluate the content, clarity, and alignment with the curriculum. The WISE unit has been revised based on their suggestions. The participating teacher was an experienced master teacher with nine years of teaching experience and previous experience in using WISE units. The teacher implemented the WISE unit '*Gene Pool Explorer'* as an introduction to the subsequent topic of evolution after having completed several weeks of introduction to genetics.

3.3 Pretest-posttest construction

Knowledge integration provided the design rationale for both the curriculum unit and the assessment. Knowledge integration items were constructed to measure qualitative and quantitative changes in the connectedness between concepts (described as the level of knowledge integration). The pretest/posttest consisted of different instruments to track changes in students' understanding of evolution: eleven constructed-response short-essays (explanation items) (Liu, Lee, & Linn, 2010) and a concept map generation item (see table 1). Eight of the explanation items were preceded by multiple-choice questions that included normative and common non-normative concepts.

Instrument	Measurement	Variable
Pre/posttest multiple-choice and short essay items	Integration of concepts and shift from non-normative towards normative concepts	Knowledge integration score
Knowledge Integration Map (KIM)	A) KIM indicator concepts indicate shifts in prominence of of normative concepts	Indicator concept prominence score
	B) KIM cross-links indicate integration of genotype/phenotype level concepts	Crosslink score

Table 1: Assessment instrument overview

3.4 *Pretest-posttest concept map construction*

For the pretest, posttest, and the embedded concept mapping activities, this study used a form of concept map, called Knowledge Integration Map (KIM), which highlights connecting concepts from different levels by dividing the drawing area in a genotype and a phenotype level into which students needed to sort out the provided concepts (Schwendimann 2015; Schwendimann & Linn, 2015) (see figure 1). Students were given eleven concepts belonging to either the genotype or phenotype level (*natural selection, DNA, genetic drift, population size, gene, environment, adaptation, mutation, genetic diversity in gene pool, increase in fitness of population, and allele*), which aligned with concepts in the pre/posttest items and the WISE unit. The provided selection of concepts aimed to model experts' understanding which concepts are most central to understanding evolution. KIMs were designed to support knowledge integration processes by eliciting existing concepts, adding new concepts to the map, distinguishing alternative concepts through revision tasks, connecting concepts within and across levels, and applying concepts by generating explanations of scientific phenomena. Students had to develop their own criteria how to identify important connections between concepts. Student dyads needed to negotiate how to categorize each concept (by placing it in the corresponding area (genotype or phenotype), which connections and arrows to create, and which link labels to add. Figure 1 illustrates the different elements of the KIM worksheet: (1), evolution-specific levels (genotype and phenotype) (2), instructions (3), given list of concepts (4), and a starter map (5). All KIM activities used the electronic concept mapping tool CmapTools (Cañas *et al*, 2004).

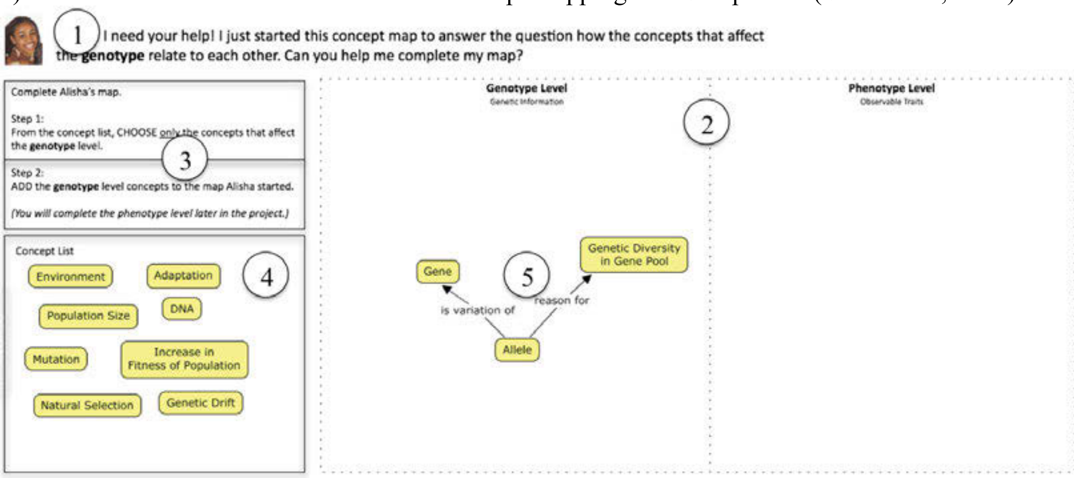

Figure 1: KIM worksheet

3.5 *Pretest-posttest analysis*

Student learning of concepts related to evolution was analyzed by comparing pretest and posttest scores. KI items distinguish the quality and quantity of connections that students construct among concepts. Pretest and posttest constructed-response items were scored according to a six-scale KI rubric (0-5) to measure changes in students' abilities to select normative over non-normative concepts and connect concepts (see table 2). A higher KI score indicates a higher number of connections between scientifically normative concepts and was interpreted as more integrated knowledge of scientific concepts. Explanations including a single concept or a mixture of correct and incorrect elements were coded as ‘partial. ‘Basic’ explanations needed to connect two normative concepts with a correct link whereas ‘full’ explanations consisted of three or more correctly connected normative concepts. Each KI explanation item was independently scored by two raters: For the pretest, the ICC coefficient was 0.84, analysis of variance F = 1.49; and for the posttest, the ICC coefficient was 0.88, analysis of variance F = 11.45. For both tests, there was no significant difference between raters, and the level of concordance was high. The mean of the two ratings was used for the analysis and calculated as a total pre- and posttest score (maximum KI score 11x5=55). Each explanation item of the pre- and posttest was weighted equally. Changes in KI items from pretest to posttest were analyzed using paired t-tests with Holm-Bonferroni corrections to adjust for multiple comparisons (Holm 1979).

KI level	KI Score	Student Sample Answer
No Answer (blank)	0	None
Offtask	1	I don’t know.
Irrelevant/Incorrect	2	Finches develop new beaks to adapt to a new environment
Partial	3	Finches inherit traits from their parents.
Basic	4	Finches have differently shaped beaks that give them different chances to survive natural selection.
Complex	5	Natural selection causes those finches with helpful mutations to their beaks to be more genetically fit and adapt to the environment better. Therefore, the finches with the beaks adapted to their environment are more likely to reproduce and the trait gradually becomes dominant in the group.

Table 2: Knowledge integration sample rubric

For the post-hoc analysis, students were stratified into two performance groups according to their KI explanation item pretest scores (low and high prior knowledge of concepts related to evolution). To determine the effects of the unit on the two groups, a linear mixed effect analysis with robust standard errors was conducted using the mean posttest score as the dependent variable, the mean pretest score as the independent variable, prior knowledge (pretest performance dummy variable) as the grouping variable, and the classes as random variables. Mixed-effect linear models were chosen to take clustering due to nested data (students within classes) into account. Robust standard errors were calculated using the Huber-White sandwich method (Huber 1967; White 1980).

3.6 Pretest-posttest KIM analysis

To track shifts in students’ connections between concepts, each KIM proposition (relation between two concepts) was scored independently by two researchers using the six-scale KIM knowledge integration rubric (0-5) (propositional analysis). For the pretest KIM, the ICC coefficient was 0.96, analysis of variance F = 4.92; and for the posttest KIM, the ICC coefficient was 0.94, analysis of variance F = 5.85. For both tests, there was no significant difference between raters, and the level of concordance was high. The mean of the two ratings was used for the analysis (KIM overall KI score). Table 3 shows the KI rubric for the relationship between the concepts ‘mutation’ and ‘genetic diversity. All propositions were weighted equally. Analogous to the KI explanation item analysis, a linear mixed effect analysis with robust standard errors was conducted using the mean KIM overall KI posttest score as the dependent variable, the mean KIM overall KI pretest score as the independent variable, prior knowledge (pretest performance dummy variable) as the grouping variable, and the classes as random variables. Robust standard errors were calculated using the Huber-White sandwich method.

In addition to the KIM propositional analysis, two complementary analysis methods were used to track changes in students’ understanding. First, network analysis was used to identify changes in students’ perceived importance of the chosen concepts (prominence). One concept from each level was selected as the ‘indicator concept’: ‘mutation’ for the genotype level and ‘natural selection’ for the phenotype level. As students develop a more complex understanding, they might also identify certain concepts as more important and connect them more often. Increases in the frequency of usage of these selected concepts served as indicators for a more integrated and normative understanding. Changes for each indicator concept are reported using the variable ‘prominence score’, calculated by adding up the KI scores of all connections leading to or from each indicator concept (Schwendimann 2014).

KI Score	Link label quality	Link Arrow	Sample Propositions
0	None (No connection)	None (No connection)	
1	Wrong label	Wrong arrow direction	Genetic diversity includes mutation
2	a) No label	a) Only line	a) Mutation -- genetic diversity
	b) Correct label	b) Wrong arrow direction	b) Genetic diversity –contributes to > mutation
	c) Incorrect label	c) Correct arrow direction	c) Mutation – includes > genetic diversity
3	No label	Correct arrow direction	Mutation --> Genetic Diversity
4	Partially correct label	Correct arrow direction	Mutation – increases -> Genetic Diversity
5	Fully correct label	Correct arrow direction	Mutation – causes random changes in the genetic material which in turn increases -> Genetic Diversity

Table 3: KIM knowledge integration sample rubric

Second, links between concepts placed in the genotype and phenotype level (cross-links) are of particular interest as they can indicate "creative leaps" (Novak & Canas, 2006, p. 2) in understanding by the creators of a concept map and reasoning across ontologically different levels (Duncan & Reiser, 2007). This study interpreted cross-links as important indicators of students' emerging knowledge integration as they link between genotype and phenotype level concepts. The sum of all cross-links are reported in the variable 'KIM cross-link KI score', calculated by adding up the KI scores of all cross-links. Changes in KIMs (overall proposition score, cross-link score, indicator concept prominence scores) from pretest to posttest were analyzed using paired t-tests with Holm-Bonferroni corrections to adjust for multiple comparisons. The same pretest performance groups (low/high) were used for the KIM explanation item analysis.

4 Results

Overall, students showed significant learning gains from pretest to posttest in the multiple choice and explanation items (see table 4).

KI		Pretest			Posttest			Paired t-test	Significance (with Holm-Bonferroni correction)	Effect size
	n	Min	Max	Mean (SD)	Min	Max	Mean (SD)	t (DF)	p-value (level)	Cohen's d
KI multiple choice items	94	6	21	15.73 (2.68)	11	22	16.87 (2.38)	3.66 (93)	0.0004 (***)	0.45
KI explanation items	94	6	40	27.64 (5.90)	12	50	30.78 (5.62)	6.21 (93)	0.0000 (***)	0.63
KI normative evolution concepts variable	94	0	4	0.58 (0.92)	0	4	0.88 (1.06)	2.68 (93)	0.009 (**)	0.30

Table 4: Overview table of knowledge integration explanation items: All students (*p<0.05; **p<0.01; ***p<0.001)

Between-subjects analysis indicates that students in both strata (low/ high prior knowledge of evolution in the pretest) significantly gained in integrating normative evolution-related concepts from pretest to posttest (see figure 5). Findings suggest that especially low performing students gained considerably after using the WISE unit 'Gene Pool Explorer'.

Knowledge integration items		Pretest			Posttest			Paired t-test	Significance (with Holm-Bonferroni correction)	Effect size
Condition	n	Min	Max	Mean (SD)	Min	Max	Mean (SD)	t (DF)	p-value (level)	Cohen's d
Low prior knowledge	38	6	27	22.5 (5.34)	12	38	27.66 (5.34)	5.67 (37)	0.000 (***)	0.66
High prior knowledge	56	28	40	31.13 (3.01)	26	50	32.89 (4.79)	3.44 (55)	0.001 (**)	0.44
KIM overall KI score	91	0	58	28.63 (11.44)	0	89	39.56 (14.09)	7.50 (91)	0.000 (***)	0.85
KIM cross-link KI score	91	0	15	2.99 (3.57)	0	30	7.85 (5.47)	8.15 (91)	0.000 (***)	0.47

Table 5: Overview table of KI explanation items and KIMs by prior knowledge group (*p<0.05; **p<0.01; ***p<0.001)

To determine the effects of low and high prior knowledge, a linear mixed effect model analysis indicates a regression coefficient of the mean KI posttest score variable of 0.61 (SE = 0.08), $p < 0.001$, which indicates that students with low and high prior knowledge improved in integrating concepts related to evolution from pretest to posttest after using the WISE unit '*Gene Pool Explorer'* (see figure 2).

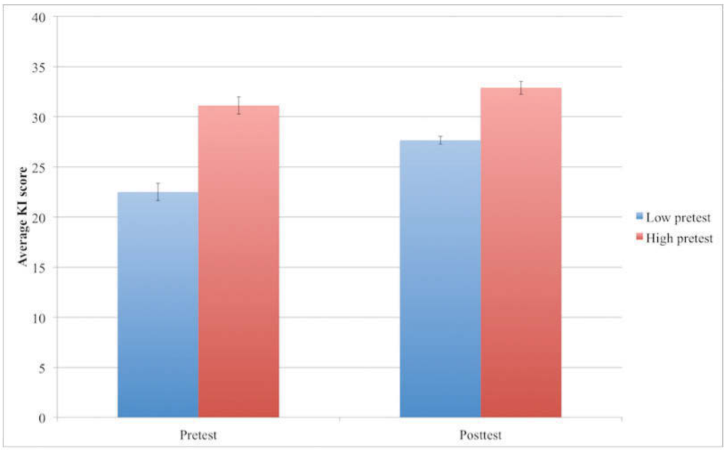

Figure 2: Pretest-posttest gains of low- and high-prior knowledge students

A composite variable for normative evolution concepts has been created from selected KI explanation items that focus on the mechanisms of evolution. The items were recoded to distinguish non-normative concepts (KI 0, 1, or 2), mixed concepts (KI 3), and normative concepts (KI 4 or 5). Paired t-tests with Holm-Bonferroni corrections suggest that students overall used normative evolution concepts more often than non-normative concepts in the posttest than in the pretest ($t(93) = 2.68$, $p < 0.01$.

KIM analysis: Overall, students improved the quantity and quality (KI scores) of connections between concepts in KIMs from pretest to posttest (see table 5). The prominence score for the two indicator concepts suggests that students made significant gains integrating these central normative evolution concepts (see table 6). Paired t-tests with Holm-Bonferroni corrections indicate that the prominence score for both KIM indicator concepts increased significantly from pretest to posttest: genotype level concept 'mutation' ($t(91) = 5.41$, $p = 0.000$ (two-tailed); pretest mean (SD) = 6.21 (4.51); posttest mean (SD) = 9.34 (5.21); Effect size (Cohen's d) = 0.31) and the phenotype level indicator concept 'natural selection' ($t(91) = 5.90$, $p=0.000$ (two-tailed); pretest mean (SD) = 4.88 (3.43); posttest mean (SD) = 7.78 (4.70); Effect size (Cohen's d) = 0.33). Posttest results suggest that students placed the indicator concepts 'mutation' and 'natural selection' more often correctly in the corresponding area, generated more connections to/from the indicator concepts, and that these connections were of higher quality (KI scores). These observations indicate that the normative concepts 'mutation' and 'natural selection' gained in explanatory strength (prominence) in students' repertoire of concepts. Figure 3 shows a student example of changes of the prominence of indicator concepts in KIMs from pretest to posttest.

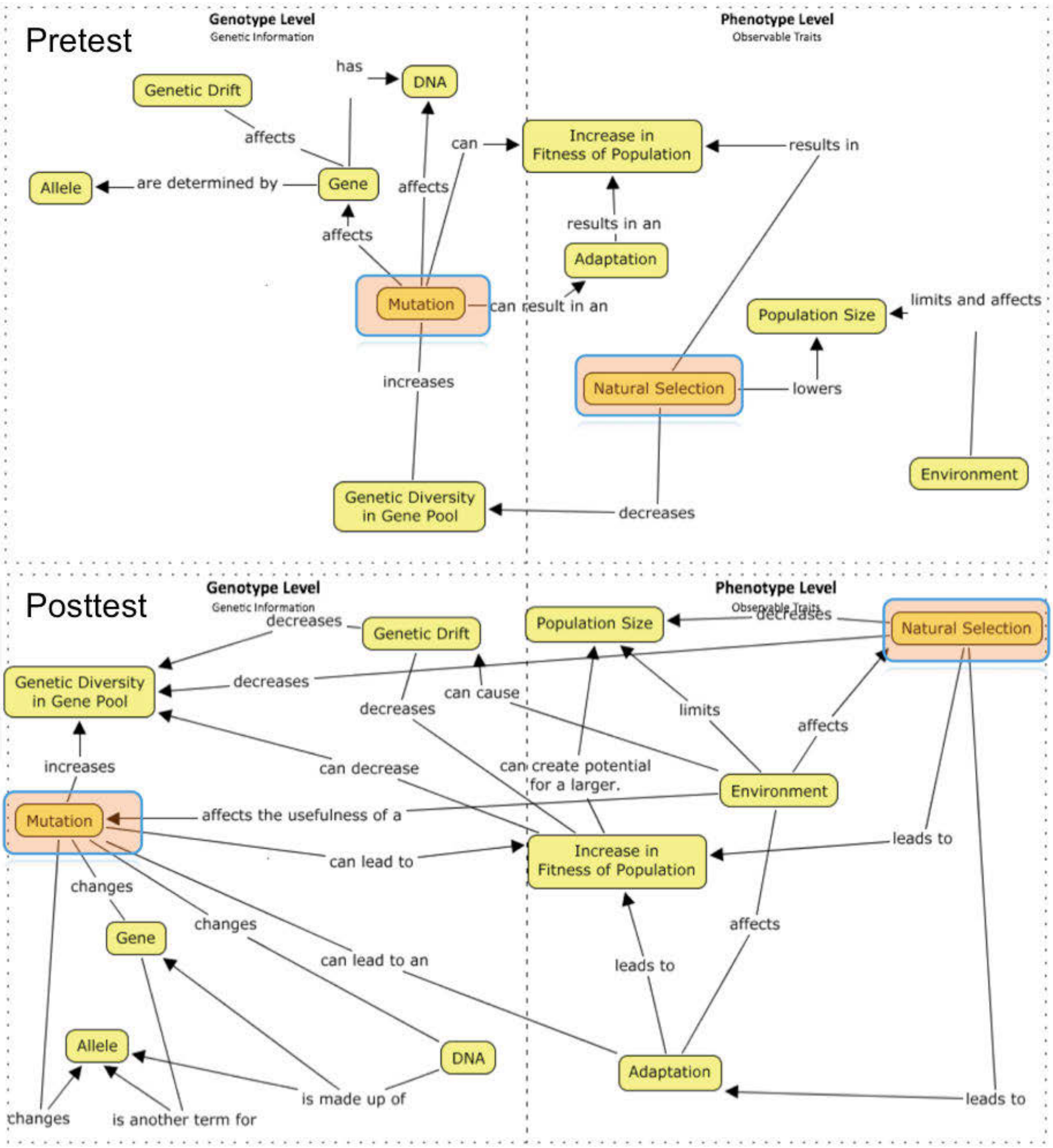

Figure 3: KIM student example (pretest and posttest)

To determine the effects of low and high prior knowledge, a linear mixed effect model analysis indicates a regression coefficient of the mean KIM posttest score variable of 0.51 (SE = 0.11), p = 0.000, which suggests that students with low and high prior knowledge generated better KIMs by connecting genotype and phenotype level concepts from pretest to posttest after using the WISE unit '*Gene Pool Explorer'*. These findings align with paired t-tests using Holm-Bonferroni corrections (see table 6). Both low and high prior knowledge students improved significantly in the prominence score for the indicator concepts 'mutation' and 'natural selection'. Gains in prominence of the indicator concepts 'mutation' and 'natural selection' observed in KIMs align with increases in the KI composite variable for normative evolution concepts.

		Pretest	Posttest	Paired t-test	Significance Level (with Holm-Bonferroni correction)	Effect size
	Variable	Pretest mean (SD)	Posttest mean (SD)	t (DF)	p-value (level)	Cohen’s d
Overall	Mutation placement	0.61 (0.49)	0.84 (0.37)	4.25 (91)	0.0001 (**)	0.53
	Mutation number of links	1.76 (1.17)	2.53 (1.24)	5.20 (91)	0.000 (***)	0.64
	Mutation total KI score	6.21 (4.51)	9.34 (5.21)	5.41 (91)	0.000 (***)	0.64
By KI pretest knowledge	Mutation total KI score (Low prior knowledge)	5.73 (4.19)	8.30 (4.91)	2.74(36)	0.0095 (**)	0.56
	Mutation total KI score (High prior knowledge)	6.53 (4.72)	10.04 (5.33)	4.77 (54)	0.000 (***)	0.70

Table 6: Within-subjects and between-subjects statistics of changes in usage of indicator concept ‘mutation’

KIM cross-link analysis: Results indicate that students significantly increased the number of cross-links between genotype and phenotype level concepts from pretest to posttest, (N=94): Pretest mean=1.03 (SD=1.15). Posttest mean=2.52 (SD=1.66). t(93) = 7.49, p< .001; effect size (Cohen’s d) = 1.04 (which can be considered a large effect size) (see table 6). The average number of cross-links increased from 1 to 2.5. The number of KIMs with no cross-links was reduced from 43.6 % to 7.3 %. The KIM with the highest number of cross-links had four cross-links in the pretest and eight cross-links in the posttest. The KIM cross-link KI score indicates the quality of links between genotype and phenotype level concepts. The median (50^{th} percentile) of the cross-link KI score increased from 2 to 7. The highest KI score of cross-links doubled from 15 to 30. This indicates that students did not only generate more cross-links but also propositions of higher quality. The increase of cross-links suggests that the WISE unit ‘*Gene Pool Explorer’* strengthened students’ integration of genotype and phenotype level concepts. Mixed effect model analysis indicates a regression coefficient of the mean KIM cross-links score variable of 0.39 (SE = 0.16), p = 0.01, which suggests that students with low and high prior knowledge generated more cross-links connecting genotype and phenotype level concepts from pretest to posttest.

5 Conclusion and Discussion

Understanding the theory of evolution is crucial to understanding modern biology. To illustrate to mechanisms of evolution, this study distinguished between interrelated genotype (micro-level) and phenotype (macro-level) concepts, which were elicited in embedded KIMs and explored in scaffolded inquiry tasks. Findings from the pretest KI items and KIMs illustrate that students entered the unit with a rich repertoire of alternative concepts of evolutionary change, a fragmented understanding (indicated by the lack of cross-connections between genotype and phenotype level concepts). Initially, many students used non-normative concepts to explain evolutionary changes. Pretest-posttest gains, triangulated through different forms of assessment (multiple choice, explanation items, and KIMs), indicate that the WISE unit ‘*Gene Pool Explorer’* facilitated an improvement in knowledge integration and a shift towards normative concepts. Changes in KI explanation scores and KIM cross-link scores indicate that the WISE unit ‘*Gene Pool Explorer’* facilitated students’ integration of genotype and phenotype level concepts of evolution. Findings suggest that a stronger integration of genotype and phenotype level concepts coincides with an increase in explanatory strength of normative concepts and a concomitant decrease of explanatory strength of non-normative concepts. Changes in explanatory strengths were identified through triangulating KI explanation items and KIM prominence scores. The analysis of posttest KIMs suggests that the normative concepts ‘mutation’ (genotype level) and ‘natural selection’ (phenotype level) gained in prominence in students’ repertoire of concepts as they became more connected in students’ maps. Increases in KIM cross-link scores indicate stronger integration of concepts across the two levels. Post-hoc analysis of low and high prior knowledge groups suggests that the WISE unit '*Gene Pool Explorer'* can facilitate knowledge integration processes of all students, particularly learners with low initial understanding of evolution.

6 Limitations and Outlook

The WISE unit '*Gene Pool Explorer'* was implemented for a relatively short amount of time with a small sample size. A longer unit or a series of units with more participants could provide further insights into designing units that support knowledge integration processes of complex concepts in biology.

This study tracked changes in non-normative concepts. Explanations of evolutionary changes (in essays or concept map propositions) often use anthropomorphic language (Alters & Nelson, 2002). Even scientists and science educators frequently use anthropomorphic terms, such as 'need', 'desire', or 'intention' (Evans, Spiegel, Gram, & Diamond, 2009) to describe evolutionary change. Some argued that scientists might use teleological terms intentionally as shorthand or metaphors (Ariew 2003), while being aware of the underlying scientific processes. Legare and Evans found that need-based reasoning can provide a conceptual scaffold towards a scientific understanding (Legare, Lane, & Evans, 2013). However, using such accessible but possibly misleading language can also reinforce non-normative concepts of evolutionary theory (Jungwirth 1977). In both cases, learners need well-designed curricula and tools to distinguish normative and non-normative concepts, for example through scaffolded inquiry activities and knowledge visualization tools, such as KIMs (Schwendimann 2015) or MySystem (Linn & Chiu, 2011).

7 Implications

The WISE unit '*Gene Pool Explorer*' used a specific form of concept map, Knowledge Integration Maps (KIM), as summative and formative activities to elicit existing concepts and facilitate the generation of new connections. Like all forms of knowledge visualization, KIM tasks need to be preceded by an initial training phase to familiarize students with the basic techniques for generating and revising concept maps. KIMs aim to visualize and facilitate connections between genotype and phenotype level concepts. Collaboratively distinguishing concepts into different categories and highlighting cross-connections in KIMs can support knowledge integration processes of complex topics. When using KIMs, students might try to find the one "correct answer" for a KIM. Teachers should stress the point that each KIM is unique, and that there are many different possible solutions for a good KIM. This study used evolution-specific KIMs that distinguished between genotype and phenotype levels. By using different levels specific to other topics, KIMs could be adapted to support knowledge integration processes in other areas.

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GOING DOWN TO THE LATE 1980'S: THE COMBINED USE OF THE 5 QUESTIONS AND CONCEPT MAPS TO APPROACH POEMS

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Abstract. This paper aims at pointing out Novak and Gowin's project at Cornell Graduate School, in the mid 1970's, on the use of knowledge construction and organization tools known as Concept Mapping combined to the Five Questions. These teaching and learning techniques were implemented to improve their own students 's views on educating so as to motivate those grad students to incorporate such tools in their future, or actual, classroom practice. As one of those students, this author followed Novak and Gowin's steps in her classes in Brazil by applying both the early combination of the 5 Questions+ Concept Maps and Concept Mapping in itself. This text displays three instances of such joint use: two with the author's college students from the perspective of a participant observer and actor, in the context of Literature classes; the third one displays an instance of this author's knowledge construction process based on her experience as Novak and Gowin's student. The examples are records of classroom practice events in this privileged milieu for critical thinking, knowledge construction, and human empowerment for both teacher and learners. This paper emphasizes the relevance of these tools within the meaningful learning theoretical framework (Ausubel, 2000; Novak and Gowin, 1984) to grant teacher and learners a higher degree of freedom to act upon their own management of knowledge comprised in Literature classes. It also stresses the value of concept maps+ the 5 Questions as instruments that facilitate negotiating and sharing meanings to achieve learning how to learn.

1 Introduction

This paper, which derives from the author's personal experience as grad student and college teacher, reports examples of college students' processes of knowledge construction as a group work related to the combined use of the 5 Qs and concept maps with literary texts. Examples of such application are displayed in three short poems chosen precisely for their size and fast reading. These instances of use with poems might meet one's need or want to see how these two tools can work together.

Initially, before the launching of user-friendly computers, the Internet, and CmapTools (Cañas et al, 2004) students were analogical using typewriters, hand-written texts and assignments, as well as producing hand-drawn concept maps. Such poems appear here in recent copies using CmapTools of the original hand-drawn maps. The 5 Questions and Concept Maps integrate cooperative class activities that facilitate students' actions towards the sharing of meanings to be grasped and the going back and forth to the draft of their work with the tools so as enable students to modify their expression of thoughts over time, as they could go deeper into feelings and ideas represented in the poems. They worked at their own pace as a group to think more about the poems and to improve the ways they had structured knowledge about the poems with almost the same ease they might have today with all accessible technology. *Almost* because with today's availability of copy and paste and other possibilities, this going continuous retake to one's knowledge production can be done with less effort, which seems to make a difference in a universe marked by fast mass production.

Concept mapping, since those classes at Cornell up the author's last days of teaching Literature to college students, was applied to promote students' autonomy to learn as well as to refine their skills in working as a group. It seems relevant to add that these three decades of concept map use in combination, or not, with the Five Questions in language and literature college teaching have been motivated by Professor Novak's classes at Cornell (Moreira, 1977, 1988) as one of his graduate students involved in the concept map project and by Gowin's ideas of knowledge structuring (1970; 1981). At the time Prof. Novak was testing it with students in the Ithaca (New York) school area district, Prof. Gowin was introducing the use of the 5 Questions as an instrument to unveil knowledge embedded in texts, objects, and events. Prof. Gowin, right after this author had shown him her work with the 5Qs in the poem "Getting Old"[1], by the Brazilian author Mario Quintana, became so much motivated that asked her to apply concept maps and the 5Questions to some of his own poems[2]. He wanted to check whether, or not, concept maps and the 5Qs would work with literary texts, as he had already gathered enough evidence of their value as knowledge unpacking and structuring tools in scientific texts and research projects. When she handed him the concept maps and the answers to the 5Qs applied to his poems, the results took him by surprise, "I now realize some ideas and feelings in these poems I have not been aware of so far!" he exclaimed. He asked her to show them to Prof. Novak. From then on Literature teaching and learning became a locus of application of these two tools. Inasmuch as in the mid-1970's, it was standard procedure, while unveiling a literary text, to use the 5Qs first to get more awareness of its concepts (related to feelings, thoughts, and events) and, as a natural follow up, to organize the chunks of knowledge revealed through the 5Qs, to have students draw concepts maps as a kind of

[1] Translation of Marli Merker Moreira as a result of a presentation in the discipline Seminar on Translation, Cornell University, 1976.
[2] Such work with Gowin's poems could not be presented here since it concerns an unpublished manuscript.

a pictorial road guide to what they had already constructed about a given text. Results of application of both tools have never been considered as apt to render the final product since learning is an ongoing process: constructed knowledge can be modified as new readings, peer interactions, meaning negotiations occur. The same pattern is followed in the examples presented here and they represent instances of an event that happened at a given time, therefore, they do not intend to be the end result for the 5Qs and/or the concept map. Classroom practice should emphasize education as a continuous process for human empowerment geared at changing the meaning of experience.

2 The Combination of the 5Qs + Concept Maps

According to Gowin, "*the key event in any learning theory should be a teacher teaching meaningful materials to a student who grasps their meanings*" (Gowin, 1981, p. 28) hence, to help a learner share and negotiate such meanings, he proposed a technique, or heuristic, (Gowin, 1970) to facilitate the unveiling of knowledge embedded, more specifically, in research papers, scientific texts in journals and books. By knowledge, he refers to as "*the results or products of inquiry since he is concerned with what others have produced through research and inquiry*" (p.86). He called it the 5 Questions that is "*a method of analysis*" and *such questions and answers can be asked and answered in any order* but all *of them must be used because together they establish coherence in the structure of knowledge* (p. 88). Its purpose is to clarify general and abstract concepts so as to change and construct new meanings from *old* concepts that can be linked to novel ones by thinking and feeling about a text in its context and inserted in the learners' milieu. Knowledge built through deliberate thinking processes about concepts and their relations should be unpacked and structured (Schwabb, 1962) with the support of the 5 Questions. With this heuristic applied to texts, students can "*experience the facility that comes with knowledge in this form, and they experience the fundamental base for subsequent learning*" (p. 88).

Gowin (1970) devised this tool to help teachers and learners unveil and understand knowledge structures in a given domain leading to new linkages in the students' cognitive structure in addition to possible future applications to other texts and life experiences. The original Five Questions related to scientific and technical texts were (Gowin, 1981, p.88): A) What is/are the telling question/s? B) What are the key-concepts? C) What is/are the method/s of inquiry? D) What is/are the knowledge claim/s? E) What is/are the value claim/s?

The telling question(s) is /are asked to organize one's thoughts about a text. It helps readers get focused to go about a piece of written/oral/pictorial text. Any text asks and/or provokes at least one question, if it does not there a problem with such text. Gowin (1981) states "*Telling questions tell on the phenomena of interest. They open events up for further search*" (p.90). The key concepts are linked to the telling question since "*a concept is a sign or symbol that refers to regularities in events*" (p. 92) and facts and help define the "*conceptual structure in a field of study*" (p.92). The method of inquiry "*is a way of trying to answer the telling questions*. [...] *It is knowledge on how to proceed, to get things done*" (p.98). A concept, according to Novak (1986) "*is a perceived regularity in events or objects designated by a label*" (p.3). Knowledge claims are the answers to the telling question/s and it is/they are *the product of inquiry*" that "*includes a question, concept, methods, and techniques as constituents of the process that produces the knowledge claim*" (p.101). Value claims "*assert the worth of something*" (p.105) connected to the construction of knowledge derived from a text.

In its application to literary texts, the initial set of questions underwent minor changes to fit literary texts. They are: A) What is/are the telling question (s); B) What are the key concepts? ; C) What method does the writer/poet/author use to represent his/her ideas and beliefs[3]? D) What is/are the knowledge claims? E) What are the value claims of such piece of literary writing? In addition, the first step, before going into the questions, is to establish the phenomenon/phenomena of interest—linked to the telling question—handled in a given literary text, such as in Shakespeare's *Hamlet*, it could be *revenge*. This acts as a focal point—theme—that assists readers in getting into their prior knowledge base, meanings associated to the topic, situations, vocabulary, language patterns, and oral/written stories.

The Five Questions together with concept maps allow for structuring and constructing knowledge issued from a text. These questions and answers, as well as their relationships with previous knowledge and experiences, can be organized to build up knowledge—a human construct (Gowin, 1981)—whose structure implies the negotiating and sharing of feelings and thoughts released in willful actions to attain knowledge. It is considered a technique geared at making sense of instructional, technical, informative, imagistic, and/or literary materials. Learners, as

[3] This third question was modified from the original one ("What is the method of inquiry?") for, according to Gowin , it would offer unnecessary difficulties to learners in handling knowledge construction related to literary studies. It then, since 1977, in the particular case of this author, included elements of language use, elements of style, figurative language, text form selected.

well as teachers, can grasp the underlying meanings that make up for the wholeness of a text. Such heuristic focuses on finding answers to the major questions embedded in a literary text so that when its reader answers those queries assisted by what he/she already knows and/or his/her previous experiences and beliefs, he/she can uncover the questions the text proposes and answer them accordingly. Thus, he/she unveils knowledge, organize it, and expand meanings comprised in a given text to other future instances and to his/her reading history, and life experiences.

Meaningful learning is also at the basis of the Five Questions and concept mapping, when those tools are used in educating events and contexts. As instructional tools for meaningful learning, they offer students and teacher "*a way to help students see the meaning of learning materials*"(Novak & Gowin, 1984, p.2). The Five Questions initially started up as a set of guiding questions whose answers could help organize knowledge about the text and, thus, facilitate comprehension of scientific research projects and articles. The 5 Q's started up with no deliberate connection to improve teaching, but to help higher education readers find their way in texts for reviewing literature while developing a better knowledge structure for their own thesis or dissertation project.

Ausubel (2000) states that meaningful learning *"involves the acquisition of new meanings form presented learning material*"(p.1) and that it "*requires both a meaningful learning set and the presentation of potentially meaningful material to the learner*"(p.1), stressing that language facilitates meaningful learning since it can increase "*the manipulability of concepts and propositions through the representational properties of words*", so that it "*plays an integral and operative role in thinking rather than merely a communicative role*"(p.5). Meaningful learning and the use of language are active processes in a continuous movement towards human empowerment: learning how to learn grants autonomy and freedom to think, feel, and act towards one's educating processes. Literature is *language in artistic use and it is ultimately there to give pleasure. Read intelligently, it is one of the highest pleasures life has to offer*" (Sutherland, 2011, p. 1). These two heuristics are directed at providing ways to achieve a knowledgeable access to capture feelings and thoughts encapsulated in a poem or any literary text. "*The work of Literature is, largely, the reader's job. To read is to construct: investing black marks on a white surface with meaning and, as one goes, shape. […] Works of Literature are not there, fully made—even the shortest, most imagistic works, which can be gulped down in a single eye bit*" (Idem, p. 121). These sentences stress the need of feeling and thinking to break out the secrets between the lines of a poem. Students as readers need these two tools since even experts, such as *literary critics, often describe poetry as 'heightened language', meaning that the poet strives for precision and richness in the words he or she uses*" and "*the poet may deliberately select a word whose older meaning adds a dimension to the poem*", students and readers of poetry are required to pay "*more scrupulous attention to unusual words and phrases"* (Abcarian & Klotz, 2007).

Concept maps are viewed here as visual representations of how knowledge is hierarchically structured in a person's cognitive structure. They facilitate interactions between those involved in the educating event as they help bring out to the surface concepts and their linkages to express in pictorial representations chunks of organized knowledge extracted from materials, as well as those concepts that already belong to the student's knowledge structure (prior knowledge). A concept map "*makes evident what the student does understand*" and "*what concept maps tell us is always part of the educational activity* (Cañas & Novak, 2012, p. 47). Coon & Mitterer (2008) state that concepts are ideas that represent categories of objects and events whose meaning is personal and/or emotional so that it fits better into connotative meanings, since the denotative one can be found in a dictionary, as a definition. Concepts are idiosyncratic while definitions are public. No concept is finally learned (Novak and Gowin, 1984), and no concept map is a final construct, since learning is a continuous process (Brown, 1994). A human being is a lifelong learner: he/she learns from the environment, or context; from involvement in reading, listening, and writing; from studying and inquiring. Koeller (1981) explained concepts as mental representations persons have of features of objects and events they use when reporting on them. This means that concepts might presuppose the generation of mental images that, while sharing some common features with other persons' mental images for a given concept, can possess other characteristics that are not necessarily shared by the other members of the group. Concept maps are externalized constructs and shared artifacts (Gao et al, 2007) that can draw on the students' cognitive structure so as to visually represent their understanding of a topic, in this case, a literary text. These two tools enable users to start with what they are familiar with while offering valuable opportunities of knowledge construction through linkages of new concepts and events to what exists in the students' knowledge structure. Teachers should know how to transit in the content area they are to deal with; otherwise they might not be fit to offer students suitable guidance throughout the work with these instruments. Teachers should be aware of where they stand to facilitate students' actions towards learning. Concepts can become pregnant with such new meanings that aim at facilitating the students learning, as the person becomes a responsible actor in the ongoing process of knowledge construction.

3 The Use of these Two Tools in the late 1980's within the Meaningful Learning Framework

The two examples of college students' collective representation of their processes of knowledge construction related to Literature were expressed with the combined use of these two tools of knowledge construction and organization. Students worked with the 5Qs and drew their individual, small group and classroom group concept maps by hand since personal computers were a thing of the future and the use of CmapTools was even further on in time. A group of grad students of Computer Science at Cornell University, in the mid 1980's, before the launching of Microsoft Windows™, devised a program to draw a concept map using an IBM™ floppy disk especially developed for Prof. Novak's students in a discipline on Ausubel's Meaningful Learning Theory. It was very far from the idea of a user-friendly technological tool: drawing a rudimentary concept map required sitting at the computer desk for hours to get a poor representation of one's knowledge on a given topic. The goal here was to familiarize students with computers that would, in the near future, play an important role in the daily life of teaching, learning, business, entertainment, work, and daily activities.

Concept mapping and the Five Questions were applied to promote students' autonomy to learn as well as to improve skills of interactive group work through negotiation and sharing of meanings since these mediating activities could promote meaningful learning for they facilitate and explicit linkages between what the learners already know and the novel concepts they are to grasp. Such heuristics can make easier the externalization of knowledge in representations—linguistic and pictorial—of the learners' cognitive structure. The examples show learners' actions when involved in feeling + thinking and sharing meanings about poems while using the target language (English as a Foreign Language) in their interactions. As a side effect, there was an increase in EFL interaction—a major obstacle in foreign language classes since students either monitor themselves constantly, or end up using their native language when dealing with their own feelings for fear of making mistakes (Krashen, 1985). As the author had already carried out experiments (Moreira, 1988, 1994) with the 5 Q's and concept maps, she decided to use examples of students, in the 1980's, working together cooperatively (Johnson & Johnson, 1998) to construct knowledge with these instruments to share their feelings+thoughts while structuring and constructing knowledge about the poems "Miracles" (Walt Whitman), and "In a Station of the Metro (Ezra Pound). They showed concept linkages they had established in each poem as they unveiled knowledge from the layer of meanings between the words and lines of the poems. In addition, the author included the poem that helped create room for Literature in the use of such knowledge structuring tools, that is, "Getting old", by Mario Quintana. In this example, Prof. Gowin contributed by inquiring about the author's answer to 'What does it mean to get old?' to which the author emphasized the sadness of loneliness in an almost empty house visited by ghosts. He reviewed my answers and added his thoughts and feelings. Thus, such example comes from the author with Gowin's added suggestions.

These tools combined can offer roads to travel through texts by revealing knowledge based on them as they empower teachers and students to think + feel + act upon what they read taking actions towards learning how to learn (Novak & Gowin, 1984). These tools encourage teaching and learning (in which students play the major role) because they promote an encouraging classroom atmosphere for interactions in which the teacher acts as a guide. Unpacking knowledge from literary texts involve brainstorming, discussion, and explanations that spontaneously derive from the involvement of students + teacher with the 5Qs and concept maps. The steps for approaching the poems and applying the tools included: students discussing their findings and doubts; brainstorming on the key-concepts and the focal questions proposed by the texts; negotiating meanings; organizing knowledge derived from the poems and linking it to what students already knew; discussing the answers to the questions and the concepts' hierarchy; completing the 5Qs; production of a concept map. The examples here do not display the group explanation of the concept maps as it occurred orally so that no record could be recovered.

Students, after handing in their work, stated that the large group discussion, which attempted at explaining the map, engendered the development of new linkages, deletion or addition of concepts, and/or changes in the hierarchical structure of their map. These features agree with the thoughts of Ausubel (1978, 2000) and Novak & Gowin (1984): learning is a continuous process. The outcome of this constant evolution is that not only novel knowledge can change—with new meanings attached to it and/or old meanings being disclaimed as not sufficiently relevant—but the existing prior knowledge can become more inclusive, and with a larger scope of meaningfulness.

4. Instances of Combined use of the Five Questions and Concept Maps

The author offers three examples of records of educating events, in which the combination of these two tools was applied to poems for unveiling and organizing knowledge[4]contained in them. Students first read the poems, thought about them, expressed their feelings derived from the texts, and brainstormed on the poem. Afterwards, they went on acting out by critically thinking about possible answers to the 5 Qs, which was followed by a classroom discussion on the knowledge constructed with the use of this tool. When students complied with the thoughts and feelings proposed in their answers, as a follow up, they read once more the poem and used their answers to the 5Qs to draw a concept map to represent what they had learned about the text. While drawing it, interaction among peers and teacher (Johnson & Johnson 1998) continued so that not only the maps were modified but also their answers to the 5Qs. These examples of the 5 Questions and Concept Maps in practice (Moreira, 1988) with real students, hopefully reconstruct possibilities of their combined use as it was in the beginning of the Concept Maps saga. Examples are actual instances that start with the use of the 5Qs followed by a concept map that represented the students' cooperative answers as a group of equal partners.

Why, who makes much of a miracle?/ As to me I know of nothing else but miracles,
Whether I walk the streets of Manhattan, /Or dart my sight over the roofs of houses toward the sky,
Or wade with naked feet along the beach just in the edge of the water, /Or stand under trees in the woods,
Or talk by day with any one I love, or sleep in the bed at night with any one I love,/ Or sit at table at dinner with the rest,
Or look at strangers opposite me riding in the car, / Or watch honey-bees busy around the hive of a summer forenoon,
Or animals feeding in the fields, / Or birds, or the wonderfulness of insects in the air,
Or the wonderfulness of the sundown, or of stars shining so quiet and bright, / Or the exquisite delicate thin curve of the new moon in spring; / These with the rest, one and all, are to me miracles, /The whole referring, yet each distinct and in its place.
To me every hour of the light and dark is a miracle,/Every cubic inch of space is a miracle,/Every square yard of the surface of the earth is spread with the same,/Every foot of the interior swarms with the same./To me the sea is a continual miracle,
The fishes that swim-the rocks-the motion of the waves-the ships with men in them,/What stranger miracles are there?

4.1 Walt Whitman's "Miracles" (Whitman 1980, p. 255)

4.1.1 The Five Questions

The Five Questions start with the students establishing the phenomenon of interest: *wondering about miracles*. A. What is/are the telling questions: a) What does a miracle mean to the poet/narrator? b) Where does the poet search for miracles? c) Can the poet understand those miracles? B. What are the key concepts? I—MIRACLES –SEA STREETS—SHIPS—TREES—HOUSES—WAVES – SKY—BEACH—BIRDS—FISHES—STRANGERS. C. What is the method used? Ideas are presented through verses without rhyme. The language is quite familiar (common vocabulary), and the sentences are in direct order (SVO) Repetitions and echoes give the reader the idea of a never-ending circle. The use of the present tense is linked to the ideas of repeated actions. The characters of this poem are the narrator (I) + the environmental context. Time and place can be any time and any place. Its climax is the final question presented about the strangeness and mystery of everyday small wonders. D. What are the knowledge claims? a) Miracles to the poet are all people, animals, and the things we have around us in Nature and its wonders; b) The narrator searches for miracles in the simplest things of life; c) He admires them and can feel and find them in tiny bees, although he cannot explain them. They are visible, however, the poet cannot find the answer to his own "What stranger miracles are there?" E. What are the value claims? a) Wonderful things—miracles—can happen to those able to admire small things in Nature; b) It is in the simple ways of daily life that miracles are born; c) if we look around ourselves willing to find miracles, we will succeed.

4.1.2 A Concept Map

As the students wanted to check the chunks of knowledge they had derived from their work with the 5Qs about the poem, they drew a concept map to represent their understanding of the poem based on feelings and thoughts in addition to what they had already constructed while answering the five questions.

[4] Examples , except for the third one (on "Getting Old"), are actual EFL classroom events in a discipline of Literature, in 1989, in a university in Rio Grande do Sul, Brazil.

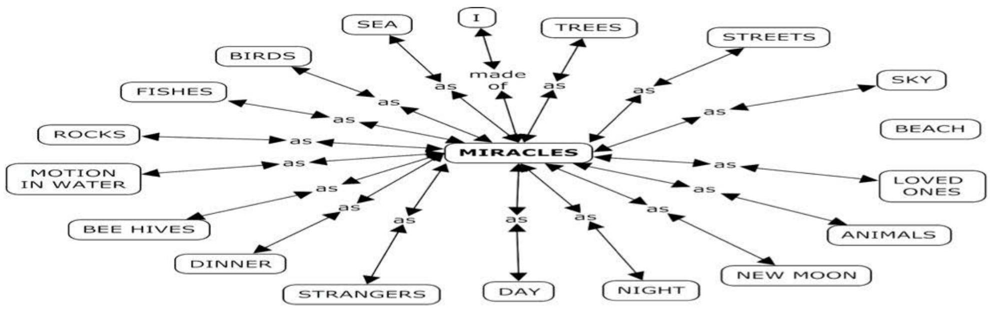

Fig 1. A concept map for Miracles (Walt Whitman) derived from the student's work with Gowin's 5Qs and based on Novak and Gowin's tenets about concept mapping (Novak & Gowin , 1984).

4.2 Ezra Pound's "In a Station of the Metro" (Nadel, 2010, p. 30)

Students' reactions to the two-line poem can be summed up with the word frustration. They immediately took a stand: the impossibility of going through the 5 Q's and of drawing a concept map for the poem did not offer enough substance to come up with questions and answers or to draw a map on it. There was a student who said it was the dullest piece of poetry ever read. They read and reread it; then a brainstorm started about the use of language, context, metaphor, and grammar issues. They felt ready to start with the 5Qs.

The apparition of these faces in the crowd;
Petals on a wet, black bough.

4.2.1 The Five Questions

As usual, before starting to define the 5Qs, students identified the area of interest of the text: beauty in the eyes of the beholder. A. What are the telling questions? a) What is the apparition made of? b) Why is it called apparition'? c) Why is it 'faces in a crowd'? d) Why is there a comparison between the apparition to petals in a wet, black bough? e) Why is the word 'wet' relevant? B. What are the key concepts? APPARITION—FACES—CROWD –PETALS –WET, BLACK BOUGH—METRO STATION. C. What is the method used for conveying meanings? a) No verbs; b) 14 word in two verses; c) use of comparison—petals in a wet, black bough; d) use of a synecdoche— faces used for persons; e) use of a sequence of two words beginning with the same letter/sound b, in black and bough to provoke an impact on the reader; f) artful choice of word order plus the absence (though present in the reader's mind) of verbs produce a burst of meanings; g) the use of prepositions (in the crowd and on a wet, black bough) as tool to make up for the image the poet/narrator paints, that is, in a crowd leads to the idea of faces as integrated in the crowd, whereas on the bough such petals/flowers/faces stem from the bough. D. What are the knowledge claims? a) The apparition is made of the fusion of faces in a mass/crowd, but some of them are salient (petals) in the blackness of the exit of the station of the metro from whose depth they suddenly emerge; b) It is an apparition for its unexpectedness (silence and darkness); c) The crowd has salient faces that appear as petals in a dark painting as if they were strokes of individuality on a painting that breaks expectations with those individual "petals on a wet, black bough"; d) Those faces that suddenly emerge (apparition) from the darkness add some light to the context, as glistening petals; e) It might have been raining (the poem was written in Paris) and this element adds a unique glaze to the petals/faces in the crowd. The wet, black bough might be the mass of persons emerging from the exit of a Metro station, and the petals are touches of revealed individuality. E. What are the value claims? a) Simple scenes bring many feelings and thoughts; b) There is no need to squander words to express one's thoughts; c) Prior experiences in life, and one's history of readings are relevant to construct the 'big picture' implied in a text and in what the poet deliberately does not explicitly say.

Those answers were discussed in class causing additional thoughts about the poem. Students could not believe 14 words (no verb) could give rise to all the issues that constituted their interactions, brainstorming, and answers to the 5Qs.

4.2.2 A Concept Map

The starting point for their concept map was knowledge they had already organized with the questions. Not much was added to thoughts about the poem in the corresponding concept map (Fig.2): Students argued that they had already squeezed all knowledge comprised in the poem with the questions. Their map mostly structured, information and knowledge students had unveiled with the 5Qs. However, faces and petals were hierarchically displayed as more significant than the crowd and the narrator (the poet as the persona) appeared as the most inclusive concept, since he was the feeler, observer, and thinker in that event. It is a pictorial representation of knowledge that students, interacting and contributing as a group, derived from their answers to the 5Qs notwithstanding some relevant modifications: a) narrator appears as the most inclusive concept; b) faces and petals get more saliency than the crowd. Additions to the concept map stem from investing additional time for thinking and feeling about the poem.

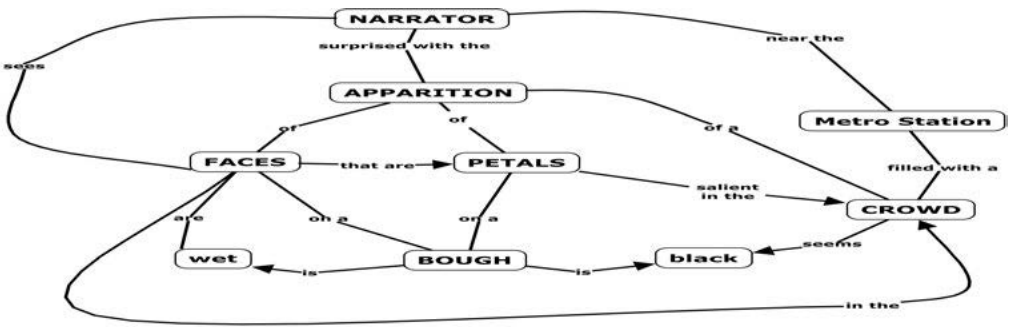

Fig 2. A concept map for Ezra Pound's poem "In a Station of the Metro".

4.3 Mario Quintana's "Getting Old" (Quintana, 1949): the author's use of the combined tools as a grad student

Before, the roads all went. *Now, the roads all return.* *Home is cozy, books are few.* *And by myself I prepare tea for the ghosts.*

This poem constitutes Gowin, Novak, and this author's first experience with the application of the 5Qs and concept maps to a literary text, in 1976. It all started with "Getting Old", which the author translated from Portuguese into English as a task in the discipline Seminar on Translation (Comparative Literature). It is approached here, for the first time this author applied 5Qs and concept map to a literary text, in 1976. However, in this 1988's version, it includes Prof. Gowin's thoughts and feelings related to the poem such as a) getting old is part of having a longer life; b) is being able to indulge his ghosts and show them he welcomes their company; c) it is a treat to be well enough not to need anyone to help him prepare tea for ghosts (remembrances of what roads brought him back); d) his home is inviting because he has uncluttered it of inessential things: home is the place for his favorite stuff; e) books are few on his own choice. His observations have modified the meaning of the author's experience on the getting old topic mostly by helping her to see that one could be content and satisfied with life, even in one's late 70's. The original version (1976) looked at the poem with different conceptual goggles concerning the process of aging and being old: she felt just the sad tone of Quintana's poem, with which Gowin did not agree. Thinking and feeling more deeply about it, she agreed with his arguments, hence this new way of looking at the same issue.

4.3.1 The Five Questions

The phenomenon of interest is aging and its issues. A. What are the telling questions?: a) How does the persona/narrator feel about getting old? b) Why did the roads all go, before? c) Why, now, the roads all come back? d) What do roads stand for? e) What makes the home cozy? f) Why are the books few? g) Why is it relevant to prepare tea for the ghosts h) Who are the ghosts? B. What are the key concepts? NARRATOR—AGING—ROADS—GOING—COME BACK—HOME –CHOICES—COZYNESS—BOOKS—CAPABILITY—TEA—GHOSTS. C. What devices (method) does the author use to construct meaning? a) Short poem with four verses with a 1st person narrator; b) comparison/opposition (before and now/ to go/to return); c) four sentences in common language with five verbs; d) the first sentence (verse) is in the simple past tense to create a contrast with the present tense (now); e) the contrast between past and present saves the use of more words and/or sentences: BEFORE: many books; cluttered house, road calls with plans and adventures/ NOW: no need/time to take heed of road calls; much to remember of what roads got him back; happiness to live in a cozy home; life has enabled him to pamper his ghosts, instead of fearing them; capability and satisfaction to prepare the tea for the ghosts. D. What are the knowledge claims? a) The persona/narrator seems to feel at ease with getting old because he can face roads he does not want to take, or he might not even care whether they go or come back and, besides, he can pamper the ghosts that come to visit him; b) The roads perhaps continue to go somewhere but he does not care for the new horizons they used to grant him in the past (before) and might beckon to him for he is satisfied with what such roads have already brought him (now); c) Roads come back, in the narrator's view, because now he is free not to take them and to benefit from the mileage he has gathered along that time before; d) Roads stand for the paths life offers individuals at all life stages; e) Home is his favorite place in which he has chosen to be without any clutter (things he does not need/want); f) He has just kept his favorite books; g) This down to basic ceremony of tea preparation is meaningful because it is he who prepares it; f) The ghosts are good, or not so good (though important in his life) memories that caress and haunt him but that nevertheless deserve pampering. E. What are the value claims? a) Road calls can be accepted or denied as getting old makes one more aware of dangers and lies roads might bring someone; b) Getting old is getting rid of accumulated things not needed anymore; c) It is part of this journey to get wise enough to cherish one's ghosts and to pamper them by taking a nice cup of tea with them.

4.3.2 A Concept Map

The drawing of a concept map offered the natural sequence for thinking about the poem and the answers to the 5Qs. This concept map is almost thirty years old though it mirrors much about the process of knowledge construction in this poem. The author adds that her first map presented to Gowin, in 1976, displayed a stern stand about aging, hence her map expressed a melancholic view about aging, which was linked to a state of inflicted LONELINESS, filled with ghosts that were there to haunt the narrator and, at the same time, required him to, though all by himself, prepare them some tea. That representation, in those days, had been influenced by the author's feelings and thoughts about the grandfather she had left to pursue her Master's degree at Cornell. It was a sad representation of one's aging in loneliness. The answers to the 5Qs were coherent with a strong linkage between getting old and being lonely and left out to oneself. The relevance of including this instance of the use of the combination 5Qs and Concept Maps resides on the possibilities of use both concept maps and the 5Qs have in other fields of knowledge, such as the arts.

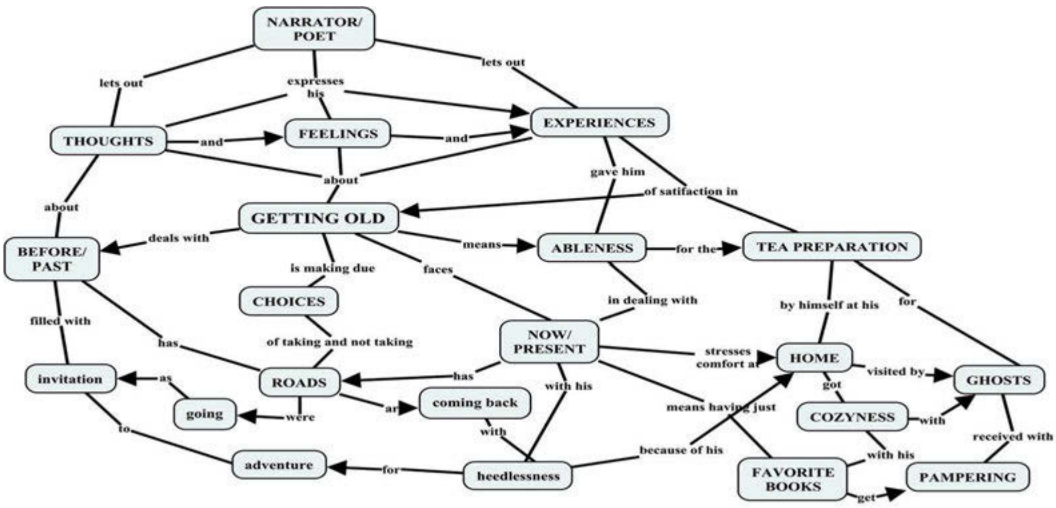

Fig 3. A concept map drawn by the author in 1988, applying to it Prof. Gowin's thoughts about the poem.

5. Summing it up: Remarks for an Ongoing Process

This work with such combination of tools—the Five Questions and Concepts maps—stresses the idea that learning situations should help students not only to unveil and construct meanings comprised in a poem but mostly to reflect upon their own experience so as to build newer and deeper meanings based on what they already have in their cognitive structure. Students, thus, learn how to learn using such tools to grasp meanings on how and why their new knowledge is linked to their experience in the world while critically thinking about knowledge embedded in poems. Critical thinking conducted by such tools might provide a way of becoming autonomous. These heuristics can help students build up self-confidence on their ability to handle new materials and anchoring newly constructed knowledge to what they already know. The use of the combination of these two educating instruments in EFL classrooms produce welcomed side-effects on teaching and learning, such as more communication in English; motivation to read a text and talk about it; a congenial learning atmosphere with students more involved in the desire to communicating than in issuing a correct form of communication. It means, less fear of making mistakes by lowering of the level of the affective filter that controls the level of such fear (Krashen, 1995) since students want to perform in English in a participative and cooperative classroom. The response we got from most of the students was enthusiastic, and they presented much interest in using these tools with their students in elementary and high school. These heuristics, or techniques, offer means of facilitating student and teacher's autonomy through thinking and interacting about Literature in the EFL classroom. Students who underwent the process of organizing and constructing their knowledge with such tools wrote a whole group comment, "*In the beginning it was very hard because we were not used to asking and answering questions about what we had read in a text, as well as to explicit the unpacked knowledge we had 'discovered' in a poem*". They also added, "*We had to think about what we knew and felt before being able to understand the verses*". Students complemented it by stating, "*Answering close-ended questions about a text is a lot easier. We don't have to reflect much upon them. With the Five Questions and concept mapping, we consider everything connected to the text. We plan to apply these instruments to other disciplines as well*."

The use of the 5Qs and concept maps facilitates the learner to take responsibility for his/her learning in a learner-centered environment. Concept maps and the 5Qs serve as reliable instruments for teacher and student, since they allow students to know the areas in which they should invest more effort to improve their understanding of a literary text, whereas teachers learn through their students' maps and answers so as to better guide students to construct, structure, and represent their knowledge. Such combination of heuristics might help improve students' confidence in their skills and knowledge, which can lead them to yield more relevant and comprehensive answers and to draw maps that more clearly represent knowledge they have unveiled from literary texts. A concept map derived from answers to the 5Qs might be a reliable indicator of the level of reading comprehension students have about a text or combination of texts. These examples from the 1980's derive from moments frozen in time as records of classroom events: participants today might add more meanings to their answers, which would produce concept maps with an improved hierarchical knowledge organization, added linkages, and new propositions. The author still agrees with what students have uncovered in their readings of "Miracles" and "In a Station of the Metro." However, she would reconsider her answers to the 5Qs and would draw a different concept map for "Getting old" in the view of Novak and Gowin's ideas about learning as a continuous process of critical thinking. It has been tough to present her 1988 record of a past educating event because of a constant openness to new learning opportunities. The world changes and, as it does, more processes of knowledge construction occur and one has added life experiences, different world views, a modified set of beliefs, a larger base of prior knowledge, and an increasingly broader scope of one's history of readings.

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HISTORICAL RETROSPECTION ON SUCCESS AND FAILURES DURING THE DEVELOPMENT OF CONCEPT MAP BASED SYSTEM IKAS

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Abstract. The paper is a retrospective look on about a decade long development of the concept map based intelligent knowledge assessment system IKAS. The research and development process is divided into several periods. During the period before the IKAS, research was focused on intelligent tutoring systems (ITS) based on agent paradigm. The beginning of the IKAS is related to studies of concept maps (CM) as teaching, learning, and knowledge assessment tools and definition of basic characteristics of the IKAS: the ability to enable systems thinking, adaptability to learners' current knowledge level, and the capacity of flexible knowledge assessment. Evolution of five versions of the IKAS, characterized by continuous extension of its functionality, went on in the period of enthusiastic work. Success and failures as well as lessons learnt during this period are described. The current situation with the IKAS and its further development directed at elaboration of improved scoring methods of CMs and formal evaluation of CM complexity is presented.

1 Introduction

The purpose of the paper is to give a historical retrospection of the development of intelligent knowledge assessment system IKAS and to summarize lessons learnt concerning success and failures. The IKAS belongs to intelligent tutoring systems (ITS), which have been a focus of research since 1970 when the SCHOLAR system (Carbonell, 1970) appeared. Thenceforth a large number of ITSs have been developed and implemented for diverse purposes in various areas. Although there are differences in the structure of ITSs, they are unified by requirements to include knowledge about what and how to teach and knowledge about learners. These requirements determine the structure of ITS consisting of three main modules (called by some authors "the holy trinity"), namely, the tutoring module, the expert (pedagogical) module, and the student diagnosis module. In addition, the communication module is needed for communication with users (teachers and learners) (Grundspenkis & Anohina, 2005).

From studies of large number of literature sources, it is concluded that from the very beginnings till the present time there remains a tendency to use ITSs predominantly as teaching and learning tools, not as knowledge assessment and/or self-assessment tools. This was the motivation for the decision that the development and implementation of the IKAS should be focused mainly on knowledge assessment aspects, leaving teaching and learning aspects as subordinate matter.

The paper is organized as follows. Section 2 briefly describes the research during the period before the development of IKAS started. Section 3 discusses the beginnings of the development, namely, arguments for principal decisions about the conception of the IKAS as a concept map (CM) based intelligent knowledge assessment system. The period of intensive work, the essence of which was a continuous improvement of system's functionality, is described in Section 4. This successful period resulted in two systems – the adaptive knowledge assessment system IKAS and the intelligent tutoring system based on holonic agents MIPITS. Section 5 represents lessons learnt and in fact discloses a dose of reality. The paper ends with conclusions – a short statement about the current situation of the IKAS, a brief description of ongoing research, and an outline of future work.

2 Research before the Development of the IKAS

The teaching staff of the Faculty of Computer Science and Information Technology (CS&IT) of Riga Technical University (RTU) came to realize that they have difficulties to handle the problem how to individualize education (at least to a certain extent) in study courses with large number of students. It was at the beginning of the millennium when the generally accepted viewpoint started to prevail that education at all levels, starting with kindergarten and ending with lifelong learning, should be ambient and must be promoted by modern information and telecommunication technologies (ICT), which enable student-centered and one-to-one learning in traditional as well as in computational environments (Waterhouse, 2004). The decision was made to find a conception on which to base the development of a system that is adaptive, enables systems thinking, and promotes systematic and computable knowledge assessment.

Literature studies helped to conclude that despite the existence of many approaches, methods, and systems supported by ICT (more than 70 different terms were found (Anohina, 2003)), the intelligent support provided by these systems and environments (distance, online, e-, m-, Web-based learning, etc.) is far behind of that demonstrated by the human teacher, who is able (at least theoretically) to adapt to each learner individually. In fact, even such e-learning systems as Blackboard (http://www.blackboard.com) and Moodle (https://moodle.org), which are the most extensively used for teaching large numbers of students, cannot adapt to specific characteristics, learning styles, and current knowledge levels of individual learners. Moreover, with the dissemination of distance learning, knowledge assessment has also become a constant concern (da Rocha, da Costa, & Favero, 2008).

3 Motivation for Principal Decisions about Concept Map Based System IKAS

The abovementioned drawbacks at least partly may be eliminated by ITSs. One of the advantages of ITSs is their ability to a certain extent to achieve the same operation flexibility and adaptability that can be shown by human teachers. Among possible alternatives, the intelligent agent paradigm was selected as the most advanced one, and sets of agents for each module of ITS were defined (Grundspenkis & Anohina, 2005).

Another advantage of ITSs is their potential capability of regular knowledge assessment, which, as a rule, is based on various objective tests, results of which are computable (Twomey, Nicol, & Smart, 1999). Subjective tests are based on essays and free text responses, which, if used in ITSs, require natural language processing (a problem for many natural languages per se). In this context, concept maps (CM) as pedagogical tools introduced by Novak and Gowin (Novak & Gowin, 1984) offer a reasonable balance between computational complexity of knowledge assessment and its correspondence to the Bloom's taxonomy (Bloom, 1956).

In brief, CMs are semi-formal knowledge representation tools that are visualized by undirected or directed graphs and use natural language to represent concepts and propositions, i.e., to represent semantic knowledge and its conceptual organization (structure). A proposition, namely, a "concept–relation–concept" triple is a semantic unit of CM, which represents a meaningful statement about some object or event in a problem domain (Cañas, 2003). A framework for conceptualizing CMs as potential assessment tools is proposed in (Ruiz-Primo & Shavelson, 1996). According to this framework, an assessment is considered as a combination of three components: a task given to a student, a format for the student's response, and a scoring system by which the student's CM can be evaluated. There is a wide variability of CM tasks, which are described in (Grundspenkis, 2011).

From studies of many literature sources on concept mapping, it was concluded that CMs have an ability to externalize the internal mental structures of learners' knowledge and they can be constructed (generated, visualized, and assessed) using ITSs. The listed advantages of CMs served as the arguments in favor of the development of CM based intelligent tutoring and knowledge assessment system.

4 Development and Evolution of the IKAS

The design of the IKAS started in 2003 with the initial goal to promote process-oriented learning and to support student-centered systematic knowledge assessment. The first prototype developed in 2005 focused on the implementation of the conception and basic functional capabilities of the IKAS. This first version was not adaptive because learners could solve only "fill-in-the-map" tasks, receiving the same given CM structure. The task was to insert concepts from a given list in correct places. The arcs of CMs were undirected and did not have linking phrases. The algorithm for comparison of CMs took into account only three constituent parts of a proposition and recognized five patterns of students' propositions. After comparison of teacher's and students' CMs, the IKAS gave feedback to students, containing information about incorrectly related pairs of concepts, a list of concepts which were not inserted, the maximum possible score for the absolutely correct solution, and the achieved actual score. The teacher received feedback with information about the scores of all learners and their CMs with highlighted mistakes. The two-tier client/server architecture was used.

During the period of active development of the IKAS, it was improved both conceptually and functionally, at the same time maintaining the basic ideas. The final conceptual model of the IKAS is shown in Figure 1.

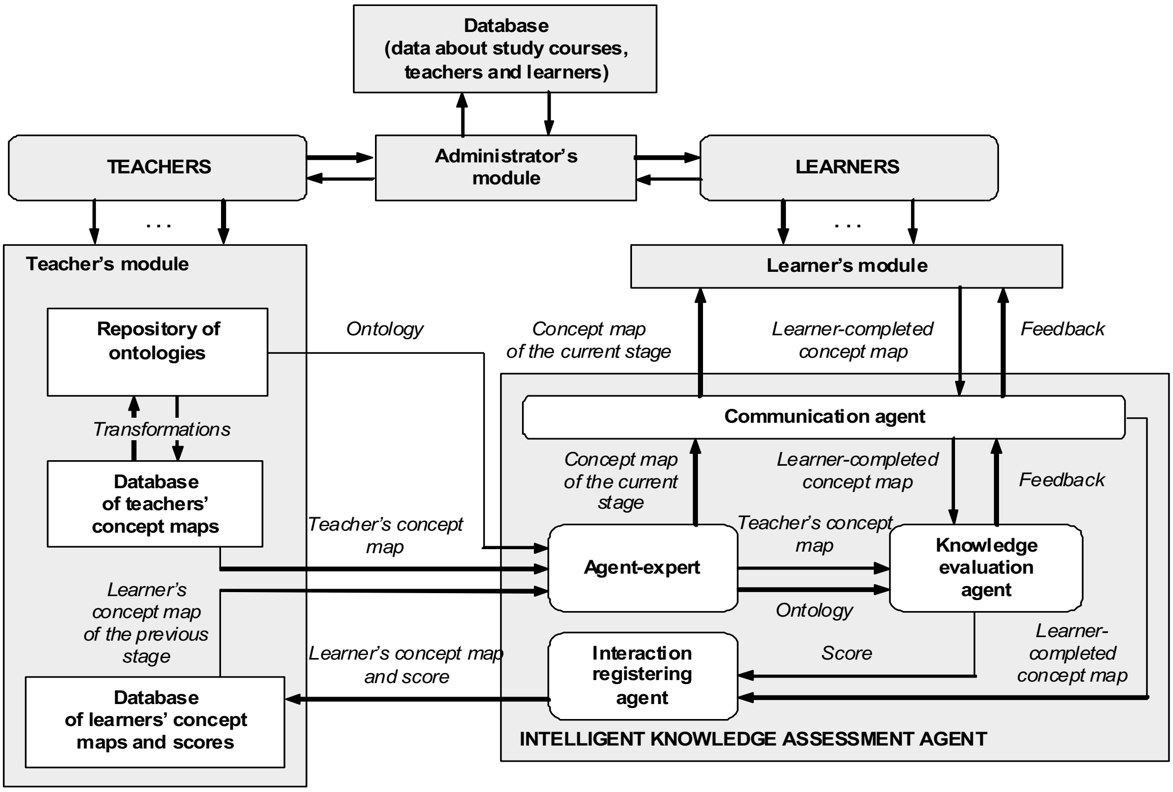

Figure 1. The IKAS and its environment; source: (Grundspenkis, 2011).

The IKAS has two classes of users – teachers and learners, who are supported by corresponding modules. The teacher's module provides the construction of CMs. The learner's module includes tools supporting the solution of CM tasks and ensures the feedback. The administrator's module manages data about users and study courses. The conception envisaged that the core of the IKAS is the intelligent knowledge assessment agent, which is implemented as a multiagent system consisting of four software agents (see Figure 1).

The IKAS conceptually supports the following scenario. Using the graphical user interface, the teacher constructs a CM for each stage in which he/she has divided a study course. The agent-expert forms a CM task of the current stage using a teacher's CM and a learner's CM of the previous stage and sends it to the communication agent (CA) for visualization. Learners receive a CM task that corresponds to the current learning stage and the preferred degree of task difficulty. When the task is completed, the learner confirms the solution, and the CA sends it to the knowledge evaluation agent (KEA). The latter compares the teacher's and the learner's CMs using graph patterns (subgraphs constituted from paths and/or cycles of limited length). For each graph pattern, the KEA assigns a score characterizing the level of pattern's correctness and calculates the final score reflecting the correctness of learner's CM as a whole. The interaction registering agent (IRA) receives the score and stores it into the database of learners' CMs and scores. The final score is included also in the feedback which the CA sends to the learner's module. The CA perceives learner's actions and makes a decision if it is necessary to change the degree of task difficulty. This agent is also responsible for the form of feedback containing information (a definition, a short description, or an example) which explains those concepts that caused problems for the learner. Besides, the CA visualizes the CM received from the agent-expert and is also responsible for the output of feedback received from the KEA. In reality, as it is described below, many ideas captured in the conceptual model of the IKAS were implemented in the successive versions.

The second prototype developed in 2006 contained new kinds of feedback: statistics on differences between teacher's and students' CMs for teachers and labeled students' CMs for students. Changing of the degree of task difficulty was implemented – students had a possibility to reduce it by asking the system to insert a chosen number of concepts. Yet more, new tasks, namely, three "fill-in-the-map" and two "construct-the-map" tasks were introduced and transitions between them were realized. Besides, linking phrases were added, the CM comparison algorithm was modified (it could compare an extended set of patterns of students' propositions), and the first version of a mathematical model for scoring students' CMs was defined.

In 2007 the third prototype was developed, in which directed links were introduced causing new modification of CM comparison algorithm. An option to define synonyms of concepts and linking phrases was offered for teachers. A set of standard linking phrases was defined.

The fourth prototype (developed in 2008) had new three-tier architecture, making it more secure and responsive. The first version of the student model was developed, and new kinds of help (additional insertion and explanation of concepts) as well as feedback (teacher's CMs were available to students, and they had possibilities to check the propositions) were offered.

The fifth prototype developed in 2009–2010 had much more informative feedback and a mathematical model for scoring CMs. Several adaptation mechanisms were implemented on the basis of the refined student model. The questionnaire system was included in the IKAS, and the user interface was translated into English. An important improvement was realization of two operation modes, namely, the knowledge self-assessment mode and the knowledge control mode.

In fact, all prototypes were developed, experimentally evaluated, and practically used within the framework of several scientific projects financed by RTU. Many theoretical ideas were concentrated in two PhD theses (Anohina, 2007; Lukashenko, 2012). Details of the whole work that are not given in this paper due to its scope are available in (Grundspenkis, 2009; Grundspenkis, 2011; Anohina-Naumeca, Grundspenkis, & Strautmane, 2011).

Unfortunately, further development of the ideas captured in the conceptual model of the IKAS (see Figure 1) was performed separately, and the obtained results have not been integrated with the system. In (Graudina, 2011) algorithms for transforming an ontology into a CM and vice versa, as well as the corresponding tools were developed. Besides, two algorithms for remediation of students' knowledge were proposed. The first algorithm generates CM based recommendation, containing information about which concepts and links should be described in a particular learning object. Once the learning materials are created and added to a CM, they are arranged into learning paths. The learning path generation algorithm sequentially adds learning objects and arranges them in levels based on their determined generality. After a student has developed his/her CM, the system evaluates it and constructs a personalized learning path, in which those propositions where the student has made mistakes are taken into account.

The issues of construction of personalized study plans, courses, and sequences of topics, and learning the concepts captured in CMs using related learning objects were solved in (Rollande, 2015). The work was done as a part of the pedagogical module of the IKAS.

It is also worth to mention the work carried out in recent years on scoring criteria of CMs (Strautmane, 2012).

5 A Dose of Reality

The targeted development of the IKAS lasted around eight years. Its last three-tier version was implemented using the following technologies: Eclipse 3.2, Apache Tomcat 6.0, Postgre SQL DBMS 8.1.3, JDBC drivers, Hibernate, VLDocking, JGoodies, and JGraph.

As it turned out, the implementation of the conceptual model of the IKAS strongly depended on skills and preferences of programmers. Maybe it sounds strange, but at the Faculty of CS&IT, the resources of corresponding programmers are very limited. As a result, the implemented IKAS is not an agent based system. So, the deviation from the initial basic idea of the IKAS conception is remarkable. It is also the reason why the IKAS does not satisfy the requirements of a software product.

In reality, the idea about a multiagent system was realized in (Lavendelis, 2009). The MIPITS system was developed for the study course "Fundamentals of Artificial Intelligence". The system adapts the search problems to the current knowledge level of each learner, taking into account his/her preferences. The MIPITS has an open holonic multiagent architecture, which is shown in Figure 2.

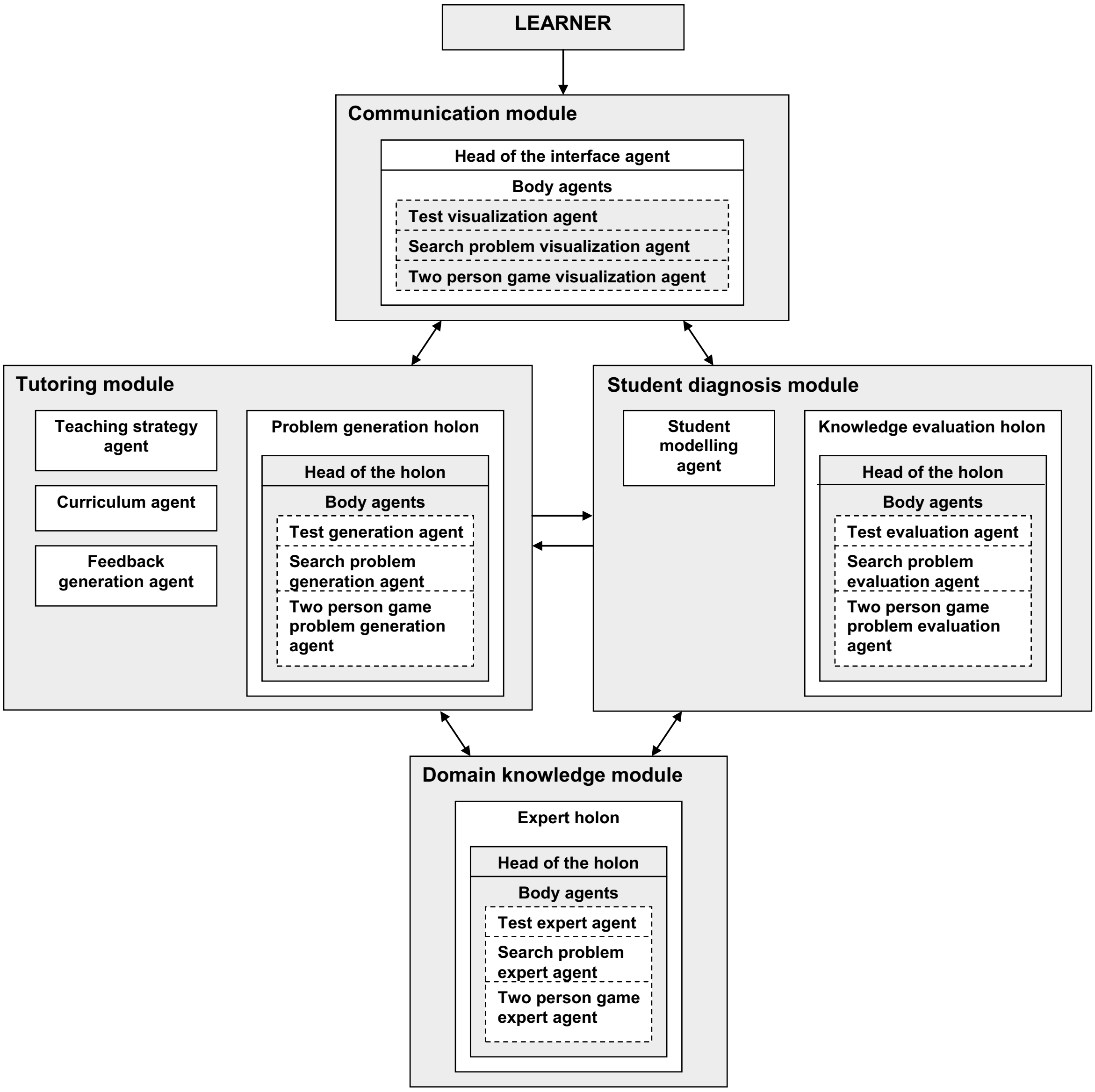

Figure 2. The architecture of MIPITS; source: (Grundspenkis, 2010).

The development of MIPITS was supported by the novel multiagent system based ITS development methodology MASITS and the corresponding tool and was implemented in the JADE platform (http://jade.tilab.com).

Returning to the IKAS, it is worth to mention that it has been practically used and tested in 17 different study courses (not only engineering courses, but also humanities) with participation of 301 students. All this work has been done only by the members of the developers' team. Although several other teachers expressed their interest and understanding of the role of CMs as education tools revealing students' knowledge structure, they failed to make effort to construct CMs for their study courses. The accent on "fill-in-the-map" tasks with different degree of task difficulty also turned out to be a failure because many students who were not motivated to study seriously soon obtained copies of correct CMs from those students who were doing well.

Moreover, the IKAS is an internet-based system, but there are problems with remote access to it from outside RTU, as well as the system fails if too many students are trying to construct their CMs simultaneously.

6 Conclusions

Even in the form how it was developed and implemented (it is an unfinished, not fully integrated system), the IKAS has several important advantages among systems of the same kind. The IKAS is a good example of combination of modern ICTs and an advanced didactic method. It supports automatic assessment of students' knowledge on the basis of CMs and provides possibilities for teachers to improve their courses and teaching methods and materials. The system can operate in the mode of knowledge self-assessment, offering a student to assess his/her current knowledge level, to change the degree of CM task difficulty, to choose tasks according to his/her learning style, and to learn more following the advised personalized learning path for knowledge remediation. The system also can operate in the mode of knowledge control intended for systematic determination of students' knowledge level by a teacher. The system provides a variety of both "fill-in-the-map" and "construct-the-map" tasks, as well as transitions between them according to the degree of task difficulty.

The implemented help assists each individual student in carrying out a task by finding a corresponding degree of task difficulty and is accessible during a task solution. Feedback, in its turn, can be given by the IKAS both while tasks are solved and after they are completed.

The scoring of students' CMs is based on a mathematical model (Anohina-Naumeca, Grundspenkis, & Strautmane, 2011), the essence of which is determination of relationship's existence, location of concepts, correctness of linking phrases, types and directions of relationships, so called "hidden" relationships (derivations of relationships presented in the teacher's CM that can be recognized as correct ones), and the degree of task difficulty. By the way, a set of graph patterns allows to deal with "hidden" relationships, which in some cases may be deduced using production rules (Anohina-Naumeca, Grundspenkis, & Strautmane, 2011).

The student model ensures adaptability. The IKAS has a production rule base that captures information about initial knowledge level and learning styles (the Felder–Silverman learning style model (Felder & Silverman, 1988) is used) of each individual student. This knowledge base is used for selection of the initial degree of task difficulty, changing the latter at the following assessment stages, as well as to set and change the priorities of types of concept explanation (a definition, a short description, or an example) included in the feedback. Priorities of concept explanation types may be changed also according to statistics collected by the IKAS during the monitoring of student's task solving behavior and, if necessary, the system automatically alters the priorities, in such way realizing an adaptive approach.

The abovementioned summarizes the current situation with the IKAS, the future of which at the moment is uncertain. It is clear that the active period of enthusiastic work has ended and at the present moment only two directions of research are worth to be pointed at. First, the importance of linking phrases and their semantics for automated CM based knowledge assessment is being investigated (Strautmane, 2014). Second, the development of a formal method for evaluation of CM complexity from the systems viewpoint with the purpose to find relations between CM complexity and the degree of CM based task difficulty is going on (Grundspenkis, 2016).

7 Acknowledgements

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IMPROVING THE READING COMPREHENSION OF IRANIAN ESP LEARNERS: A CMAPTOOLS STUDY

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Abstract. The need for technological literacy in technology-based education environments is increasing along with advancements in technology and the researchers explore to implement standards-based curriculums. This study investigated the scaffolding effects of applying CmapTools on ESP learners' academic achievements. To conduct the study, 77 Iranian ESP students in upper-intermediate level were selected randomly and taught while employing CmapTools: They were taught how to create concept maps by CmapTools software. Conducting independent samples t-test, the performances of groups on pretest and posttest were compared. The findings confirmed the scaffolding impacts of CmapTools on the learners' reading comprehension achievements.

1 Introduction

The appropriateness and effectiveness of employing technology in language classrooms are under question, whereas many research studies focused on technology-integration in reading classrooms. Some teachers appear not to have a clear and fully prepared educational design for their classrooms, thus the majority of EFL learners complain that their lexical knowledge is transient since there is no opportunity to practice their knowledge out of class time. According to a well-researched journaling in the domain of concept mapping, the concept map (CM) proponents stated that learning happens by encouraging learners to think both deeply and critically, and to comprehend thoroughly (Lynch, Fawcett, & Nicolson, 2000; Mathes, Torgesen, & Allor, 2001; Blok, Oostdam, Otter, & Overmaat, 2002; Nesbit & Adespe, 2006).

The technology has been integrated into language learning environments and eventuated in the advent of technology-based educational tools such as CmapTools (Cañas et al, 2004). CmapTools is a kind of software that assists learners to construct CMs more easily and more effectively. In addition, scaffolding idea creation is a prevalent practice in organizations. Today's technology makes it easy for international and intercultural group members to construct CMs together remotely and deliver their ideas together very easily, but quite surprisingly little is known about how culture and medium shape the underlying concept mapping process. Although a large number of studies investigated the role of different variables in reading comprehension from different perspectives, there is not a sufficient attention by language teachers and researchers to the significance of integrating technology-based educational tools in strategy-based reading comprehension classrooms in developing language learning skills; therefore, the present study investigated the impacts of CmapTools on learners academic achievements.

2 Review of literature

There are numerous learning styles and strategies that enhance reading comprehension skill (Hedge, 2008; Nunan, 2004; Richarad & Renandya, 2002), but among various types of instructional reading comprehension techniques, CM strategy is the focus of this study. This is a strategy which is preferred for text comprehension and specifically for accessing background knowledge. CM is a technique that allows learners to see the connections between ideas they already have, connect new ideas to knowledge that they already have in their minds, and in addition, allows learners to organize ideas in a logical structure. CM was developed in the 1960s by Joseph Novak of Stanford University. It is a metacognitive tool which is applicable to any discipline at any level and can be employed by both learners and teachers to better comprehend the content and process of meaningful knowledge (Novak, 1995; Amadieu, Van Gog, Paas, Tricot, & Mariné, 2009). Novak and Gowin (1984) introduced CM strategy as a way to facilitate the process of meaningful learning. They also defined it as a graphic organizational technique which is designed to help individuals and groups, explain and explore their knowledge and understand a topic in their classrooms. CMs are actually composed of concepts, in which they are shown in circles or boxes. The concepts are related by a connecting line which links two concepts. The linking lines contain some words which show the relationships between two or more concepts. Learners connect their previous knowledge to new information and create maps which show interrelated ideas. CM strategy provides additional motivation for language learners to detect the relationships among different sets of information (Mathes, Torgesen, & Allor, 2001).

As Novak and Cañas (2008) demonstrated, the CM technique is rooted in Ausubel's (1963) Assimilation Theory. The basic idea in Ausubel's assimilation theory is that learning takes place by the assimilation of new concepts and knowledge into existing conceptual propositional frameworks detained by the learners. According to this theory, CM has three distinctive features which include hierarchical structure, cross links and specific examples; among them the hierarchical structure is the most important and a basic feature. In Mintzes, Wandersee, and Novak' words (2000), the purpose of providing examples is just to clarify the new meaning of a given learning concept. Moreover, there are different versions of CM which includes expert-constructed, learner-constructed, fill in the map and cooperative CM.

Fisher, Faletti, Patterson, Thornton, Lipson, and Spring (1990) designed a CM system that is called SemNet. According to the semantic network theory, they illustrated that SemNet had a positive effect upon learners' map construction in the classrooms. Reader and Hammond (1994) used hypertext techniques to apply their CM system and found that those who used the CM system obtained a better achievement. The computer-based systems of Fisher et al. (1990) and Reader and Hammond (1994) prevailed over some of the limitations and the difficulties in paper-and-pencil CM, but some concerns must still be addressed. For example, the systems provided learners with an environment in which CMs could be constructed without any assistance. Beginner learners tended to be frustrated in this difficult construction process. In addition, these systems cannot provide appropriate feedback to the learners because teachers lack any effective function for evaluating the CMs. This lack of feedback means that learners have few opportunities to reflect upon their own thinking which reduces the beneficial effects of constructing a CM. Modern CM construction tools (CmapTools) provide a creative cognitive tool for organizing knowledge about concepts and ideas in different formats in which concepts are connected with lines and accompany linking words to form propositions and concepts (Novak & Cañas, 2008). This learning tool is based on the social constructivist learning theory in which learning is a self-regulated building of concepts with the help of previous knowledge (Biggs, 1999; Bransford, Brown, & Cocking, 2000). The studies that were conducted on elementary schools' learners indicated that computer-assisted reading strategies are most suited with below-average learners learning ability (MacArthur, Ferretti, Okolo, & Cavalier, 2001).

There are few experiences of using CM and its effects on learners' reading comprehension in educational contexts. A study distinguished between more and less skilled readers by Gascoigne (2002). His study showed that good or successful readers have been applied top-down strategies. The attitudes of the learners about the CM were positive, but the result of this study revealed that the CM has no significant effect on students' reading comprehension skill. The findings stated that learners with low prior knowledge benefit more from CMs than those with high prior knowledge. The process of creating CMs for a domain helps learners to gain insight into how they teach more effectively (Cañas, Hill, & Lott, 2003). Liu, Chen, and Chang (2010) investigated the effectiveness of the CM learning strategy on learners' English reading comprehension skill. The result of the study indicated that the CM learning strategy was more effective for the low-level learners than for the high-level group, in terms of their performance on reading comprehension skill. In contrast, other studies believed that CMs promoted other skills such as reflection, a self- regulatory process that is related to motivation, self- control, and self-efficacy. In other words, it increases learners' motivation in the classroom (Coulthard, 2005). In the same vein, Dias (2010) examined the effect of the strategy of CM on the second language learners' reading comprehension. The findings represented that the construction of meaning by the generation of CMs could be an effective reading comprehension strategy in English language learning contexts. Another experience by Chang, Sung and Chen (2007) on using two versions of compute-based CM: construct-on-scaffold and construct-by-self on learner learning represented that both of them are the same. In these strategies, the learners have to complete the blanks to complete the framework. And in the construct-by-self the learners face with the opportunity to construct their CMs freely and without scaffolding help. The result of the study confirmed that CM with teacher scaffolding is more effective on learner learning. Numerous educational applications of CMs can be identified in research studies that are: 1) a help in understanding, 2) a tool for the consolidation of educational experiences, 3) a tool for enhancement of affective conditions for learning, 4) an aid or alternative to traditional writing assignments, 5) an effective strategy to teach critical thinking, 6) a mediating illustration for supporting interaction among learners, and 7) a help in the process of learning by teaching. CMs have been used in collaborative and cooperative learning, and as a formal evaluation tool. CMs have been used to manage and present new information, including use as an advance organizer, use by teachers in the course or curriculum design, and use as an aid in hypermedia.

In Iran, there has been a dearth of research in the field of technology-based curriculum regarding conceptual knowledge gained from student learning in the technology-based education classrooms, and especially through Cmap techniques. The CM strategy has been utilized, especially in science classrooms and other educational classrooms to help assess learners and learn concepts and ideas and it has been described as an important meta-cognitive tool in science education. Science educators have also been utilizing and applying the CM strategy in their classrooms to help learners to learn science concepts and new ideas. The present study deals with ESP courses and the use of Cmap to improve the reading skill of learners.

In this study, the researchers intend to answer the following research question: Is there any statistically significant difference between paper-and-pencil and technology-based CMs in Iranian EFL learners' reading comprehension achievements?

3 Methodology

3.1 Participants

The participants in the study were 77 upper-intermediate Iranian female ESP students in upper-intermediate level. Their age was between 18 to 24 years old. They studied in different fields of study such as Architecture, Management, Engineering, Mathematics, and Microbiology and were assigned to four classes randomly in order to investigate the effects of employing CmapTools software on their reading comprehension ability. They were taught by four different teachers: one control group, N= 38 (class A, N=19 and class B, N= 19) and one experimental group, N=39 (class C, N= 19 and class D, N=20). It should be stated that all the participants attended the course regularly.

3.2 Materials and Instrumentations

Michigan English Language Assessment Battery (MELAB). MELAB is a standardized test created at the University of Michigan, which evaluates reading competence of adult non-native speakers of English. In the current study, reading comprehension part of MELAB test was administered to the participants to determine the students' reading comprehension competence. This test included four reading passages with total 20 multiple-choice reading comprehension questions for learners to be answered in 30 minutes. This test was employed as pretest in the current study.

Reading posttest. A reading posttest was developed from Select Reading Textbook by the researchers to determine the learners' reading comprehension competence at the end of research and after treatment. This researchers-made course-based test contained 20 items; four reading passages followed by five multiple choice questions similar to the content of the reading text book. Three experts reviewed it for its content validity and reliability. Then, the researchers revised it according to the experts' comments. Next, the test was piloted with 20 learners of similar test-takers. Cronbach's Alpha formula for multiple choice items was employed; the results showed a reliability index of .818 (r= .818).

Select readings: Upper-intermediate. This reading textbook written by Lee and Gunderson (2011, 2nd Edition) is a teacher-approved American English reading textbook series for upper secondary and university students. It contained a range of high interest reading texts approved by American experienced teachers. This four-level American English reading course uses carefully selected reading texts to assist learners to read more effectively.

CmapTools. The CmapTools software (available for download at: http://cmap.ihmc.us) developed at the Institute for Human and Machine Cognition brings together the strengths of the CM strategy with the power of modern technology. This software not only makes it easy for users of all ages to construct and modify CMs in a similar way that a word processor makes it easy to write a text, but also allows users to cooperate at a distance in the construction in their maps and publish their CMs so anybody on the Internet can access them. In addition, they can link resources to their maps to further explain their contents and modify them, and search the WWW for information related to the map (Cañas et al., 2003). This software allows the user to connect resources (photos, images, graphs, videos, charts, tables, and texts) located anywhere on the Internet or in personal files to concepts or linking words in a concept map.

3.3 Procedures

To conduct the study, the researchers invited 77 upper-intermediate Iranian female learners and randomly assigned them to two groups (four classes). They were taught by four different teachers: one control group (class A, N=19 and class B, N= 19) and one experimental group (class C, N= 19 and class D, N= 20). To find out the effect of treatment (the effects of employing technology-based educational tools such as CmapTools software on EFL learners' reading comprehension ability), participants' reading comprehension was evaluated at the beginning of the study; therefore, the participants in two groups were asked to answer the MELAB at the outset of the study. During 10 sessions (two sessions per week and every session one hour and half), participants in the experimental group were exposed to task-based classroom reading activities. The material of the study was Select Readings Upper-Intermediate textbook. The participants were assigned into two groups randomly; paper and pencil constructed CMs and technology-based constructed CMs. In control group, the learners were taught how to draw a CM by themselves through papers and pencils and had their CM through their handouts and submitted them to their teachers. Learner-constructed CMs can show teachers how learners are linking the knowledge together, instead of having learners memorize facts in a linear way. CMs allow the learners to connect concepts presented in labs, lectures and readings to their prior conceptions. They promote conceptual change, even in delayed transfer tests. In experimental group, the learners did the same, but they made and submitted their CMs through educational software. In the two first sessions, the teacher taught participants how to use the CmapTools. The participants were taught how to bring together the strengths of CM with the power of technology, particularly the Internet. After assuring that all of the participants learned how to work with the tool, the regular sessions started. These regular sessions were started with warm up questions. In the next phase, participants constructed appropriate CMs based on sessions' topics. Constructing these CMs, they used different sources of information such as Internet, textbook, and their peers. The software allowed users to collaborate at a distance in the construction of their maps and publish their concept maps; therefore, anybody on the Internet could have access to them, link resources to their maps to further explain their contents, and search the WWW for information related to the map.

A time limit of thirty minutes was finally selected as one which would permit group members to express all the ideas occurred to them within the work period (though not to exhaust all possible ideas) and yet which would not result in excessive periods of silence for individual subjects. Actually, for both individuals and groups, appreciable periods of silence appeared between responses near the end of the thirty minutes. The teacher began the session by reading the instructions aloud, the first part of which was designed to ensure a high degree of subject motivation. First, it was explained that the experiment was part of a program of research on problem solving and creative thinking. Secondly, each subject was asked to read the first three paragraphs. These three paragraphs were quite favorable to CM. Finally, subjects were specifically asked to do their best. The second part of the instruction was designed to make certain that subjects fully understood the nature of CM. Next, the groups took a reading comprehension posttest in order to check and compare their reading comprehension achievement. The participants of two groups took the post-test at the very last session of their intensive reading course. Data were collected for further statistical analyses.

4 Results and Discussions

Having collected the results of MELAB in the pretest, the researchers analyzed the data employing independent samples t-test to estimate the participants' level of reading comprehension at the outset of the study.

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Control Group	38	11.32	2.132	.346
	Experimental Group	39	12.13	2.483	.398

Table 1: Descriptive statistics for MELAB (Pretest)

As the results in Table 1 show, mean and standard deviation of two groups are (M= 11.32, SD=2. 132) for the control group, and (M= 12.13, SD= 2.483) for the experimental group respectively. The results do not show significant difference between the two groups in their general level of reading comprehension at the outset of the study. Meanwhile, to ensure true homogeneity of the participants' reading comprehension competency (N=77), Independent Samples t-test was conducted, (see Table 2).

An independent-samples t-test was conducted to compare the results of the pre-test for the participants of both control and experimental group. There was no significant difference in scores of the control group (M= 11.32, SD=2.132) and scores of the experimental group, M= 12.13, SD= 2.483; t (75) = -1.538, P = .128. The results of Table 2 confirm the homogeneity of the participants at the outset of the study.

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.451	.504	-1.538	75	.128	-.812	.528	-1.864	.240
Equal variances not assumed			-1.541	73	.127	-.812	.527	-1.863	.238

Table 2: Results of independent samples t-test of MELAB (Pretest)

To determine the effects of treatment and examine the raised hypotheses, the researchers developed a reading test. This test was piloted with 20 learners of similar test-takers. Cronbach's Alpha formula for multiple choice items was employed; the results showed a reliability index of .818 (r= .818). As the result of piloted test shows, Reading posttest proved as a highly reliable test and could appropriately act as a reading comprehension measure.

To determine the effects of treatment, the researchers employed independent-samples t-test.

Group Statistics					
	Groups	N	Mean	Std. Deviation	Std. Error Mean
Posttest	Control Group	38	11.95	1.888	.306
	Experimental Group	39	16.72	1.806	.289

Table 3: Descriptive Statistics for Reading Posttest (Posttest)

As the results in Table 3 show, mean and standard deviation of two groups are (M= 11.95, SD=1. 888) for the control group, and (M= 16.72, SD= 1.806) for the experimental group respectively. The results show a significant difference between the two groups in their general level of reading comprehension at the end of the study. Meanwhile, to ensure true difference of the participants' reading comprehension competency (N=77), independent-samples t-test was conducted, (see Table 4).

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.461	.499	-11.33	75	.000	-4.771	.421	-5.609	-3.932
Equal variances not assumed			-11.36	74	.000	-4.771	.421	-5.610	-3.931

Table 4: Results of independent samples t-test of reading posttest (Posttest)

An independent-samples t-test was conducted to compare the results of the post-test for the participants of both control and experimental group. There was a significant difference in scores of the control group (M= 11.95, SD=1.888) and scores of the experimental group, M= 16.72, SD= 1.806; t (75) = -11.33, P = .000. As the results of Table 4 reveal, learners in Cmap group over-performed those in conventional paper and pencil group; therefore, computer assisted language learning has a significant effect on learners' academic achievements.

The following sections would present detailed discussions on the results of the analyses applied to the data. One of the methods most often recommended by researchers for enhancing reading ability is using learning strategy. Through a deliberate design, it deals with linguistics learners' problems such as text comprehension as higher-level issues. In recent years, researchers have tried to deduce the principles of reading strategies from research studies. Some of the more widely recommended approaches are determining the main messages such as summarization, using text improvement, illustrations, mental images, and question and answer drills. The results of the present study as confirmed by the previous research studies indicated that computer assisted language learning can be successful to a great extent (Fisher et al., 1990; Reader & Hammond, 1994; Johnson-Glenberg, 2000; De Corte et al., 2001; Fischer, 2003; Alfassi, 2004; Yusuf, 2010).

Computer-assisted instruction (e.g. employing CM tools) has been very popular during the last two decades, and scholars agree on the feasibility of applying computers in reading instruction under appropriate designs. Consistent with the previous studies, there are several advantages of incorporating technology in reading instruction. Firstly, computers can provide immediate individual feedback based on learners' learning condition (Novak, 1995; Lynch, Fawcett, & Nicolson, 2000). Secondly, learning with computers allows learners to control the pace of learning (Mathes, Torgesen, & Allor, 2001; Novak & Cañas, 2008). Thirdly, properly arranged courses may be operated independently with computers; therefore, reducing teachers from some of the burden and giving learners more opportunities to learn independently. And finally, through managements of using different media, learners' motivation to read may be strengthened (Coulthard, 2005; Chang, Sung, & Chen, 2007). The findings are consistent with the learners' attitudes in the interviews in that, they stated that learners are strongly motivated when they are working with modern technologies in their language classrooms.

It is widely agreed by many researchers that proper multiple strategies with computer technology facilitate text comprehension abilities. However, the practical application of comprehension strategies in reading course leaves much to be investigated (Alfassi, 2004; De Corte et al., 2001; Pressley et al., 1989). But this study also finds that the advantages of strategy training as described above are not unconditional, and the performance is different with the style of learners, their levels, and their background knowledge. For example, some participants had difficulty in producing suitable concept maps when they had little background knowledge in that especial reading topic. Several possible reasons emerge after analysis. Since the reading texts used in this study were mainly scientific in nature ("A Young, Blind Whiz on Computers"), the students may have difficulty in elaborating related concepts by describing the details, citing examples and continuing the text without prior knowledge or exposure to related material. As a result, even if the learners had the intention and ability to use the strategy of integrating prior information with new concepts and ideas, they may not be able to put this strategy into real practice. In contrast, the content of the narrative ("How to Make a Speech") may provide messages that are more concrete and closer to living and to give the readers more room for imagination, so that the integration with prior knowledge and the elaboration of the concepts in the text may be easier.

The results of the current study indicated that the CmapTools, which is also a process oriented teaching environment, can benefit learners with low reading ability. Another possible reason for this benefit might be attributed to the characteristics of computer-based instruction such as individual instruction, monitoring and immediate feedback. Computer-based CM allows personalized progress by placing a learner in an independent and threat-free situation in which develops the effects of practice. This study found that these characteristics may not only have a high potential for helping learners with lower abilities in their acquisition of higher-level skills, but also for lower-level reading skills such as word-recognition and phonological awareness. This study found that while computer assisted language learning with strategy has a potential for reading instruction design, there are some points worthy of investigation.

5 Conclusions

Computer assisted language learning has significant effects on learners' academic achievements. The results indicated that the learners in CmapTools outperformed those in conventional paper and pencil CM. Integrating computer technology with strategy instruction has a potential for reading instruction design, there are some points worthy of investigation. To elaborate the design of systems like Cmap concept mapping, researchers may consider providing a wider variety of appropriate reading strategies for learners or teachers to choose from, or arrange strategies according to their own needs or preferences. Accordingly, the results of the present study indicated that this type of design can effectively enhance learners' abilities.

This process of constructing a CM strategy is a powerful learning strategy that forced the learner to actively think about the relationship between the terms. This makes CM especially suited to studying science as the learners often perceive, incorrectly, that studying science means simply memorizing facts. With CMs, information can be presented in a condensed manner, without the loss of complexity and meaning. The visual presentation allows the learners and teachers to identify the information without the dense presentation of words and verbal compositions. An increasing number of studies highlight its use in identifying learners' pre-instructional understanding of a subject. In addition to identifying learners' prior knowledge of a subject, CMs can also be used to promote cooperative learning. In this situation, learners can work in small groups and discuss their understanding of a topic and then collaborate together and produce a group CM. This approach engages learners in discourse about the concepts and encourages them to articulate their thoughts about, and experiences with, the concepts. This allows the learners to identify the connection between their conceptions they have already processed and the new learning material. The tool is extremely flexible and can be used both in instruction and assessment.

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INTERACTIVE CONCEPT MAPS CAN AUGMENT LEARNING WITH VIDEO MEDIA

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Abstract. Information-rich video media such as television science documentaries make significant intellectual demands on viewers. In watching this media, viewers are acquiring new ideas and revising their existing ideas as a kind of informal learning. Concept maps have a demonstrated value for learning in educational settings, suggesting they may also be exploited to good effect in the new technology of companion apps for television programmes - web enabled applications running on tablets and similar devices that provide accompanying synchronized content for television programmes. CompanionMap was created to investigate the potential for using animated, interactive concept maps in television companion apps. It was demonstrated with an astronomy documentary programme and evaluation with viewer participants in a controlled study showed it improved understanding and recall of the programme. The development of the concept map for the app is described with reflection on the issues arising from its use in this setting.

1 Concept maps and information-rich television programmes

As a form of knowledge representation, concept maps can be used for communicating ideas as much as for eliciting and creating ideas. These uses are well established in teaching and learning: students draw concept maps to externalize their understanding of a subject and may be given concept maps to help them understand a subject (Moon et al, 2011). Extensive research over three decades has shown that concept maps benefit learning across a wide variety of settings used in different ways (Kinchin et al, 2000; Nesbit & Adesope, 2006; Novak, 1990). One of those ways is animated concept maps, where a map of a subject extends visually as it is read. The additional of animation to a concept map has been shown to benefit learning in a comparative study with static concept maps (Blankenship & Dansereau, 2000). The possibility of presenting lesson and lecture notes in this form to accompany a teacher is clear; the map is able to provide a persistent, visual textual, representation of material presented primarily orally by the teacher. The value of concept maps used in this way has been demonstrated in a study of learning with spoken recordings where learning was enhanced by a concept map (Adesope & Nesbit, 2013).

A related use for concept maps is as a visualization for television companion apps. These are application programs, typically running on a tablet or other handheld connected device, that provide synchronized accompanying content for television programmes. When created for an information-rich programme such as a science documentary, a companion application can augment viewers' following and understanding the programme. In this setting, concept maps have a similar purpose to their use in classrooms for accompanying a teacher. The potential for representing information-rich television programmes with concept maps is already demonstrated in classrooms where teachers use programmes within their class teaching and ask students to create maps of what they have understood from the programme. Figure 1 shows a map created in a second year high school class by a pupil studying biology whose teacher was showing them an episode of the *Frozen Planet* natural history TV series. Clearly the map lacks some formal features of a concept map but is also clearly more than a simple 'mind map'.

The reasons why an animated concept map companion app might benefit viewing of information-rich television programmes can be anticipated. First, viewers will benefit from a representation of the content they have already viewed. Television is, of course intrinsically transient and viewers' recall of what they have viewed needs to be augmented since science programmes often involve relating together their parts within a linear narrative. Therefore, the concept map can provide a persistent representation of the content already viewed that can be re-consulted. Moreover, the animation of accumulating map content will allow the viewer to easily find their place in the map, to coordinate their reading of the map with their listening of the programme.

Second, viewers are unlikely to benefit from a verbatim transcript and frame-by-frame record of the programme; rather, they need an abstraction of the content that summarises the important ideas and their connections. The process of understanding the programme is fundamentally a construction of this conceptual abstraction over the content. Concept maps provide exactly this synoptic representation which is also a means of categorizing, indexing and therefore re-finding content already viewed. Interactivity clearly has to be designed carefully as extended interactivity will lead to distraction that will undermine comprehension of the programme.

A third benefit is the personalised viewing that a concept map makes possible because of its mutable and extensible form. Different viewers will have different needs and expectations for how programmes should be augmented. Viewers with a little knowledge would need more explanation to properly understand the programme, while viewers with better knowledge would need more information. Concept maps can be extended and navigated to reveal additional information. By providing choices for viewers in navigating and browsing the map, a concept map is able to provide a pesonalised interaction in a rudimentary sense. If the choices available to the viewer are constrained by their individual profile, or by the trajectory of choices already made through the map, then the map is achieving a more sophisticated degree of adaptivity.

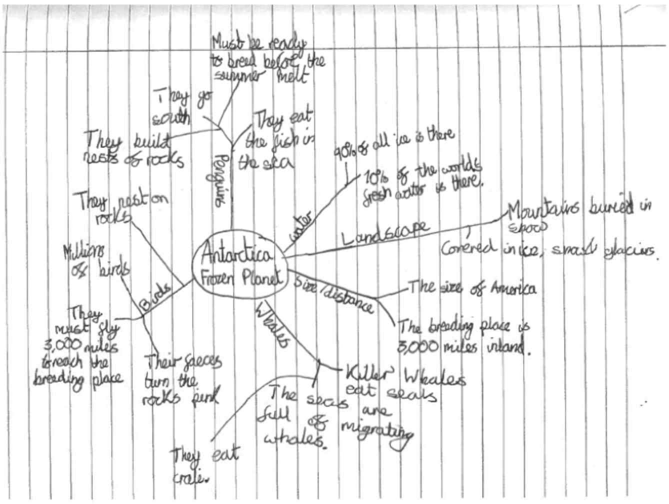

Figure 1. Concept map constructed by a high school student while watching an episode of the *Frozen Planet* natural history programme in a biology class.

Whilst these benefits of concept map based companion apps can be anticipated, there is also clearly a potential for maps to compete with the television programme for visual attention and either be ignored or distract from viewing the television. Unlike the Adesope and Nesbit study where the visual map complemented the auditory speech, television is of course highly visual and so a companion app competes for the viewer's visual attention. To investigate the design possibilities of concept maps as companion apps, and to evaluate their use by television viewers, the CompanionMap app was created as now described.

2 Developing an interactive animated concept map companion for an astronomy documentary

A concept map was created of the conceptual content of an astronomy documentary *The Seven Ages of Starlight* (BBC, 2012). Figure 2 shows a concept map of a 5-minute section of the programme concerning supernovae. The map was created using the CmapTools (Cañas et al., 2004) by a graduate astronomer in consultation with astrophysicists who had advised the makers of the programme. The nodes of the map represent the main ideas explicitly stated in the narration overlaying a set of related video images in this part of the programme. The narration has been parsed and re-expressed into these separate nodes then relationships fixed between them. The figure uses colour coding to differentiate the nodes for each successive minute of the programme. The orange shaded nodes relate to the first minute of the programme.

Development of the concept map involved a number of iterations in which questions emerged about how to translate the programme, how to apply the concept map formulation and how to create an accessible piece of communication. The labelling of the nodes with concept words or with phrases was only the first issue. The earlier versions of the map used word labels and short phrases (visible for and exists for just one night), the later versions used sentences (The explosion lasts just a few seconds but the remnant will brighten over the course of a night). It also became clear that the map needed to use only a limited set of link types if it was to be easily readable whilst watching the programme. The issue also emerged of whether the map should accurately only represent the concepts presented explicitly in the programme (by speech and visual image) or whether it should also include concepts that were missing the programme or only implied but necessary to be technically correct. The programme's producer had skillfully selected content that would be accessible for a wide audience rather than provide a substantial and complete account of the astrophysics.

A companion app was developed to present the concept map as an animation synchronized with the programme. CompanionMap was developed as a native app for the Apple iPad tablet. The app was able to import the concept map file created by Cmap, parse the file and extract the map content and geometry. The map was then animated by creating draw events for each element in the map and mapping these to time stamp tags added to events in a recording of the programme. The map was now synchronized with the programme, nodes and links appearing appropriately with the content of the programme. Colour was used to indicate the newest node in the map and the colour of the most recent nodes progressively faded, aiding coordinated reading of the map. The speed of delivery of verbal spoken content in the programme was relatively slow and dictated the speed at which new elements appeared in the map. Clearly the speed of growth of the map trades off with the density of nodes and the complexity of their labels, from a user's point of view. There are also many possibilities for the visual transitions in displaying the map. For example, it might be presented as a fixed global view that is progressively filled in with blossoming nodes and arcs. Alternatively, the view might be a roving porthole that skims across the map revealing the network of nodes 'already there'. Both a roving porthole and dynamically appearing nodes could be used. Multiple detailed presentation design decisions arise, for example, the limiting speed of transition of the moving map without disrupting reading.

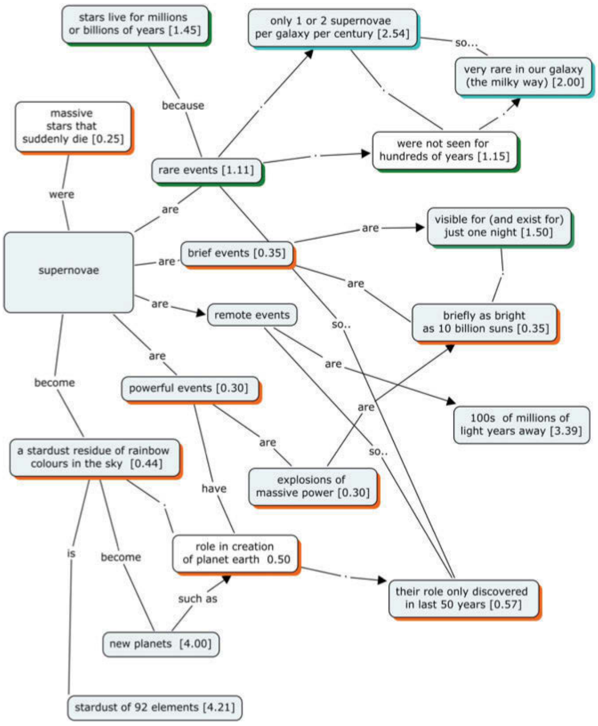

Figure 2. Concept map of the first five minutes of *Supernovae*, episode 5 of *The Seven Ages of Starlight* TV programme.

Additional interactive features were added to the map in the form of extra information cards. Tapping a node would open a card expanding on the concept of that node. The possibility for drilling down further on a node to reveal more detail means that it is able to provide a synopsis of varying abstraction. Additional interactive possibilities for the map would be allowing viewers to pause the dynamic display of the map. The map would then need to catch up with the programme if the programme continues to play, but alternatively the action would be able to pause the play of the programme if it was a recorded or on-demand session. Beyond this simple touch-and-hold interaction, viewers could navigate the map and expand and mark nodes. A further interactive feature added to CompanionMap was that nodes could be miniaturised to help viewers keep track of which nodes they had read. Interactive concept maps have been previously demonstrated as a knowledge elicitation tool (Kornilakis, Grigoriadou, Papanikolaou, & Gouli, 2004) but the companion app greatly expands the possibilities for interaction.

CompanionMap was evaluated in a controlled study involving 28 participants using the app whilst watching The Seven Ages of Starlight (Dowell et al., 2015). A within subjects design was used with participants watching two parts of the programme and using the app in one of those parts. Participant's recall and understanding of the programme were assessed using probe questions administered immediately after watching the programme. Some probe questions assessed content that was only in the programme, some assessed content that was in both the programme and the companion app. The results showed an improvement in the scores for questions assessing knowledge of content that was both in the companion app and the programme (T=2.2, p=.044). This result is positive evidence for the benefit of the concept map in aiding recall and understanding of the programme. A questionnaire examined participants' reactions to using the companion app and these were strongly positive, though some noted a difficulty in knowing at which device they should be looking at which point in the programme. A model characterising the cognitive processes involved in the multimodal cross device use of a companion app is described in (Dowell & Kim, 2015) providing an interpretation of some of these observations from the evaluation of CompanionMap.

3 Summary

Concept maps are a promising form of visualization for companion apps that augment viewing of television programmes. They provide a persistent and synoptic visual representation of programme content that may be intellectually challenging for viewers to remember and process. They connect the 'bits together' that are unnaturally separated by the linear narrative of television and similar information-rich video media. When animated they provide an accumulating representation that enables the viewer to coordinate their map reading with the programme viewing. They may interactive, opening extraordinary possibilities for actively following a programme and accessing accompanying content as individuals prefer.

CompanionMap was developed for an astronomy documentary to investigate the design possibilities and evaluate their value to viewers. Evaluation has shown that viewers' recall and understanding of the programme are improved by using the concept map and viewers also liked the experience of using the app. Many open questions remain about the form of concept mapping second screens. If done badly it is entirely possible that a concept mapping second screen would be ignored, or even disrupt viewing of the TV programme. For example, giving viewers suitable opportunities to switch their visual attention from one screen to another will need to be taken into account in the design of the app and probably the programme too. However, the development of CompanionMap and its subsequent evaluation indicate the considerable potential of using concept maps as a visualization to augment information-rich television programmes and video media.

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ITINERARIOS FLEXIBLES DE APRENDIZAJE Y MAPAS CONCEPTUALES: UN ABÁNICO DE POSIBILIDADES PARA TODOS LOS NIVELES EDUCATIVOS

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Abstract. En la búsqueda por mejorar los procesos pedagógicos de manera que respondan a las necesidades e intereses de los estudiantes y las competencias del siglo XXI, se generan propuestas de nuevos ambientes de aprendizaje que ofrecen flexibilidad, interacción, autonomía y ubican al estudiante como centro de su formación. Una de las opciones que surgen son los itinerarios flexibles de aprendizaje basados en mapas conceptuales propuestos por Cañas (2010). Como parte de un proceso de investigación que busca caracterizar los elementos que se conjugan en un ambiente de aprendizaje que usa itinerarios flexibles basados en mapas conceptuales, se diseñan e implementan seis experiencias en distintos niveles de educación y contextos, orientadas a diferentes competencias, esperando que aporten en la definición de principios y características aplicables al ambiente de aprendizaje óptimo para este tipo de estrategias. En este artículo se presentan los seis casos de estudio, los avances en los resultados y los principios para el diseño e implementación que surgen de él.

1 Introducción

Investigadores, docentes y en general los profesionales que están interesados en el campo educativo, avanzan en la búsqueda por mejorar los procesos pedagógicos, la incorporación de nuevas tecnologías en las aulas y responder a las demandas de los estudiantes y de las competencias que requieren para enfrentarse al mundo de hoy. En este proceso, surgen propuestas de nuevos ambientes de aprendizaje con diseños instruccionales más modernos que ofrezcan flexibilidad, interacción, autonomía y ubiquen al estudiante como centro de su formación.

Los itinerarios flexibles de aprendizaje basados en mapas conceptuales propuestos por Cañas & Novak (2010), se convierten en una opción para la creación de ambientes en donde el docente pone en juego su experticia y los estudiantes gozan de autonomía y flexibilidad, lo que potencia el aprendizaje significativo. Pero para que se obtengan los mejores resultados aplicando los itinerarios flexibles, se requieren unas características en su diseño e implementación.

Agudelo & Salinas (2015) como parte de un proceso de investigación que busca caracterizar los elementos que se conjugan en un ambiente de aprendizaje que usa itinerarios flexibles basados en mapas conceptuales, proponen el diseño e implementación de experiencias en distintos niveles de educación y contextos, abordando competencias diversas, que permitan el reconocimiento de elementos comunes, principios, lecciones aprendidas y sugerencias aplicables a dichos ambientes. En este artículo se presentan los seis casos que hacen parte de ese estudio que se llevó a cabo en Medellín—Colombia y los principios para el diseño e implementación que surgen de él.

2 Contexto de la Investigación

Para el diseño y la implementación de las experiencias que se presentan en este artículo, se optó por el estudio de casos en la modalidad de estudio colectivo de casos, siguiendo las etapas que recomiendan Montero & León (2002): selección y definición del caso, elaboración de una lista de preguntas, localización de las fuentes de datos, análisis e interpretación, elaboración del informe.

Con los casos seleccionados se pretende impactar diversos niveles educativos: Preescolar, primero y segundo ciclos de la básica primaria, básica secundaria, universitario y educación continua. Las experiencias se implementan en la ciudad de Medellín- Colombia con el respaldo de la Secretaría de educación y participan profesores y estudiantes (Tabla 1). Es por ello que para la selección de participantes se tuvo en cuenta que estuvieran motivados a trabajar con herramientas TIC, que les gustara innovar con estrategia activas y que estuvieran dispuestos a participar de forma voluntaria en el proceso.

Los aspectos que se trabajan y sobre los cuales se recibe y analiza la información, son: Propósitos formativos, contenidos, metodología, rol del docente y del estudiante, recursos, interacciones, seguimiento y evaluación.

Caso	Nivel/Grado	Institución Educativa	Competencia	Número docentes	Número de estudiantes
1	Preescolar	I.E. Madre María Mazarello	Conozco mi cuerpo	2	52
2	Básica Primaria/ ciclo 1/primer grado	I. E. Ana de Castrillón- sede Divino Salvador	Conozco mi cuerpo	1	42
3	Básica Primaria/ ciclo 2/quinto grado	I. E. Gabriel García Márquez	Soñando el futuro tecnológico	1	35
4	Básica Secundaria/ Noveno grado	I. E. Gabriel García Márquez	Construyendo mi proyecto de vida	2	116
5	Universitario/ Administración	Universidad EAFIT	Seminario de síntesis	5	450
6	Educación Continua/ docentes	Secretaría de Educación de Medellín	Potenciar el aprendizaje significativo – mapas concept.	1	25

Tabla 1: Condiciones de implementación de estudio de casos.

3 Marco de Referencia

El diseño instruccional, los ambientes de aprendizaje apoyados en TIC y los mapas conceptuales hacen su aporte en el diseño de itinerarios flexibles de aprendizaje, orientando la identificación de características que son aplicables en su diseño e implementación.

3.1 Diseño Instruccional

El Diseño Instruccional (DI) se encarga de generar la estructura y secuencia de los contenidos y disponer los conocimientos o experiencias de aprendizaje al alcance de quienes estén dispuestos a aprender. Representa el puente entre las teorías del aprendizaje y su puesta en práctica, por lo tanto reflejará el enfoque teórico que se posea respecto a los procesos de enseñanza y aprendizaje (Benitez, 2010). El Diseño Instruccional debe facilitar el procesamiento significativo de la información y del aprendizaje, por tanto ha de ser capaz de enseñar el conocimiento organizadamente (Martínez 2009).

Díaz (2005), hace énfasis en la necesidad de contar hoy con diseños flexibles, orientados o centrados en el alumno, la previsión de interacciones constructivas, el diseño de entornos de aprendizaje donde se trabaje en modalidades híbridas o mixtas, donde se intercalen tutoría individualizada y en grupos pequeños, trabajo cooperativo y la generación de todo tipo de producciones innovadoras. Esa es la tendencia del diseño instruccional.

Hannafin (2000) plantea que, de acuerdo a las competencias que debe tener un ciudadano en el siglo XXI, los diseños educativos deben tener características que permitan fomentar la autonomía y la autorregulación; el trabajo colaborativo, entornos de aprendizaje abiertos; el uso de herramientas cognitivas y de las tecnologías más avanzadas, ritmos personalizados y la solución de problemas.

Como tendencia en cuanto al Diseño Instruccional, se retoma el Modelo de Aproximación Sucesivo- SAM 2 que se considera una evolución del ADDIE, en donde el Diseño Instruccional se lleva a cabo mediante procesos sistemáticos e iterativos. SAM2 tiene tres fases: Bases o Preparación, que permite al equipo recopilar información de antecedentes, lluvia de ideas para que el equipo de diseño y las partes interesadas puedan revisar la información y crear ideas iniciales de prototipo. Las fases de diseño y desarrollo iterativos se descomponen en pequeños pasos incrementales, permitiendo a los equipos la toma de decisiones y refinamiento de prototipos desde el principio.

Articular los elementos del diseño instruccional y determinar el ambiente de aprendizaje óptimo, flexible, autónomo, tecnológico y coherente para que se materialice, es un proceso que se debe liderar desde la innovación y la investigación educativa con la participación activa de los docentes.

3.2 Ambientes de Aprendizaje

Para que el diseño instruccional pueda ser una realidad, necesita un entorno en el cual materializarse: los ambientes de aprendizaje, definidos como un *espacio* donde ocurre el proceso de adquisición de conocimientos, por ello se requieren ambientes de aprendizaje que: estén mediados por TIC, se desarrollen en espacios virtuales o mixtos, sean flexibles, promuevan el aprendizaje colaborativo, promuevan el aprendizaje autónomo, tengan en cuenta los estilos de aprendizaje.

Los nuevos ambientes de aprendizaje contemplan los espacios virtuales y los que combinan la virtualidad con la presencialidad, denominados mixtos, híbridos o bimodales, los cuales, además de transmitir contenidos y recursos de información, deben posibilitar diferentes actividades prácticas y experiencias reales, el intercambio de información y opiniones y colaboración, sin limitaciones espacio-temporales. (Moreira, 2010)

El uso de las tecnologías en la educación, también representa el cambio del aprendizaje lineal al interactivo. Lozano y Burgos (2007), reconocen que en el modelo tradicional, el conocimiento es centrado en el profesor, con un esquema lineal y en un solo sentido: docente hacia el alumno, quien tienen poco grado de participación, mientras en los nuevos modelos de aprendizaje, el conocimiento es basado en el descubrimiento y la participación. Las características analizadas para los ambientes de aprendizaje actuales, encajan con los requerimientos de los itinerarios flexibles de aprendizaje.

3.3 Mapas Conceptuales

De acuerdo con Agudelo & Salinas (2013), cuánto más rica sea la estructura cognitiva de un sujeto que aprende, más interconexiones relacionales logrará entre la nueva información y la que posee y los mapas conceptuales son una representación gráfica de esas interconexiones. La afirmación anterior está basada en la teoría de la asimilación de Ausubel, teoría del aprendizaje basada en un modelo constructivista y cuyo núcleo es el proceso de interacción entre el material recién aprendido y los conceptos existentes. (Ausubel y Novak, 1983).

Pero además, los mapas conceptuales pueden ser usados para planear y organizar el currículo: una descripción del currículo mediante un mapa conceptual puede ayudarle al estudiante a tener una visión global del mismo. En su propuesta de utilizar mapas conceptuales en la planeación de un currículo, Cañas & Novak (2010), expresan que, en lugar de explicar el tema a través de proposiciones, se orientan al proceso para adquirir el conocimiento. Se trata de ocuparse del 'cómo' en lugar del 'qué'.

Los itinerarios de aprendizaje basados en mapas conceptuales son, por lo tanto, un diseño instruccional, una forma de organizar el proceso de aprendizaje que presenta rutas, opciones y recursos para desarrollar una competencia o un saber, apoyados en Objetos de Aprendizaje que guían al sujeto que aprende. Pero cabe resaltar que más que un organizador de conceptos y contenidos, el itinerario busca presentar un entorno de aprendizaje que posibilita una secuencia no lineal y facilita el acceso a objetos de aprendizaje que apoyan la construcción de conocimientos y el desarrollo de competencias.

4 Metodología

La investigación basada en diseño (IBD) apoya el diseño y exploración de todo tipo de innovaciones educativas, a nivel didáctico y organizativo. Rinaudo & Donolo (2010) realizan la descripción de la IBD a partir de tres etapas: de preparación del diseño; de implementación y de análisis retrospectivo. Para las fases de preparación del diseño y de implementación, se optó por el estudio de casos en la modalidad de estudio colectivo de casos. Este método se desarrolla en cinco etapas: selección y definición del caso, elaboración de una lista de preguntas, localización de las fuentes de datos, análisis e interpretación, elaboración del informe.

Dentro del proyecto se definen los casos que se van a estudiar, qué competencias se van a implementar, los contextos que se van a intervenir y los colaboradores del proceso. Con los casos seleccionados se pretende impactar diversos niveles educativos: Preescolar, primero y segundo ciclos de la básica Primaria, Básica secundaria, Universitario y educación continua.

4.1 Estudio de caso 1: nivel preescolar - Nombre de la experiencia: Reconocer mi cuerpo

Este itinerario se desarrolla en la institución educativa Madre María Mazzarello.
Entidad de carácter oficial, femenino, que ofrece una educación integral en los niveles de preescolar, básica y media, fundamentada en la pastoral y apoyada en los valores del Espíritu Salesiano. Las docentes participantes son dos, formadas en educación infantil, las estudiantes, 52 en total, todas de sexo femenino, pertenecen a los dos grupos de preescolar de la institución mencionada. Sus edades oscilan entre los 5 y los 6 años y sus familias están ubicadas en una clase social media.

Para este caso se diseñó un itinerario flexible, basado en mapas conceptuales para el proyecto MI CUERPO, que se desarrolla en preescolar. (Figura 1). Los objetos de aprendizaje incluyen videos orientadores, donde una niña y una profesora van explicando las actividades a desarrollar, fichas que los docentes trabajan habitualmente y juegos e interactividades en línea. Para facilitar la ubicación de los niños frente al itinerario, se trabajó con colores primarios delimitando cada módulo.

El trabajo se centra en los saberes asociados a la competencia “Reconocer mi cuerpo”, dividido en tres componentes: cuidar mi cuerpo, sentir mi cuerpo y reconocer la diversidad. En este caso, las docentes trabajaron apoyadas por los padres de familia, por lo cual iniciaron con un taller con ellos, orientado por una psicóloga, mostraron el itinerario y lo que se pretendía con él y les dieron el enlace a través del cual podrían acceder para apoyar el trabajo desde la casa.

El aula se dispuso con espacios similares a los tres componentes centrales del itinerario y en dichos espacios se iban resaltando los trabajos de los estudiantes. Las actividades finales de cada módulo son diseñadas para el trabajo colaborativo, por lo cual se propicia la organización de equipos entre los que están avanzando paralelamente.

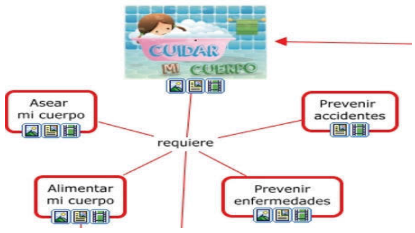

Figura 1. Vista parcial de Itinerario para el proyecto del cuerpo- Fuente propia Reacción y aspectos significativos: http://mapas.futurodigital.org:8080/rid=1N4QVQ2Y0-1RHK5DG-1CN/Proyecto%20mi%20cuerpo.cmap

El trabajo con la comunidad, fue un aspecto destacable dentro de la implementación del itinerario. Los productos que evidenciaban el logro de las competencias estuvieron muy bien planeados, por ello se pudo hacer la socialización con todo el colegio en el Carnaval del cuerpo y esto fue una oportunidad para dar a conocer los logros de los estudiantes de preescolar y las ventajas de esta nueva forma de trabajar.
Se propone organizar de esta misma forma otros proyectos del nivel preescolar, por lo cual ya se están iniciando las mesas de trabajo con las docentes.

4.2 Estudio de caso 2: nivel básica primaria - Ciclo 1 - Nombre de la experiencia: Reconocer mi cuerpo

La Institución Educativa Ana de Castrillón, es una entidad de carácter oficial, mixto, que ofrece en su sede Divino Salvador, los servicios educativos en los niveles de preescolar y básica primaria. Este itinerario se desarrolla con el grado 1º, en donde se trabajó con 42 estudiantes, cuyas edades oscilan entre los 6 y los 8 años. Sus familias son de una clase social media – baja, por lo que no todos tienen acceso a recursos tecnológicos en sus hogares.

En el caso número 2, se aplica el mismo itinerario del caso anterior, una vez evaluado por la docente y definida su pertinencia en el plan curricular que desarrolla. Las guías incluidas en el itinerario y los objetos de aprendizaje son aptos y pertinentes para el trabajo con el grado primero y los juegos e interactividades en línea ofrecen diversos niveles de dificultad. El trabajo se centra en los saberes asociados a la competencia “Me identifico como un ser vivo que comparte algunas características con otros seres vivos y que se relaciona con ellos en un entorno en el que todos nos desarrollamos” (MEN, 2004).

Dado que no se disponía de la sala de computadores con mucha frecuencia, la docente mostraba el itinerario y lo explicaba y el grupo elegía por cuál línea avanzar y ahí sí de manera individual, los estudiantes elegían las acciones y objetos de aprendizaje para su trabajo y también si querían trabajar de manera física o digital. Para este último caso debían esperar la jornada en la cual se disponía de los equipos de cómputo. Una ficha para colorear se podía hacer con la herramienta paint, de manera digital o en la hoja impresa que se facilitaba en el aula. Una reflexión sobre la mejor alimentación para nuestro cuerpo, se podría hacer en una diapositiva en PowerPoint o en una cartelera.

Aspectos Significativos y Reacción

El hecho de no tener tanto acceso a los computadores, no fue un tropiezo a la hora de desarrollar el itinerario, pues siempre estaba disponible un itinerario en el aula, con el proyector para que los estudiantes fueran avanzando. Esto suponía la gestión logística constante de la docente.

La docente que desarrolló el itinerario se motivó a formarse en mapas conceptuales para posteriormente construir sus itinerarios y también a aplicar el itinerario del tercer caso de este estudio con su grupo actual que es de quinto grado.

4.3 *Estudio de caso 3: nivel básica primaria - Ciclo 2 - Nombre de la experiencia: Soñando el futuro tecnológico*

La Institución Educativa Gabriel García Márquez, ofrece servicios educativos desde preescolar hasta 11°, con media técnica en sistemas, está ubicada en la zona centro oriental de la ciudad de Medellín. El nivel académico de los padres de familia o acudientes de los alumnos es bajo, al igual que el estrato socio económico, por lo cual los estudiantes no disponen de recursos tecnológicos en sus hogares para apoyar el proceso educativo. Este itinerario se desarrolla en la sede principal, con el grado 5º que corresponde al segundo ciclo de la básica primaria, el grupo estaba conformado por 35 estudiantes (20 hombres y 15 mujeres), con edades 10,11, y 12 años. La docente encargada del grupo impactado, es formada en maestría en ingeniería, por lo cual tiene competencias técnicas para el manejo de la TIC.

En el caso número 3, para el trabajo con estudiantes del grado quinto en el nivel de básica primaria- ciclo 2, se diseñó con la docente un itinerario: "Soñando el futuro tecnológico" (Figura 3), con el cual se busca analizar herramientas o artefactos tecnológicos desde la necesidad que les dio origen, su estado actual teniendo en cuenta la influencia e impacto social, económico, ambiental en la vida del hombre y una proyección futura a partir de un proceso de creación utilizando herramientas que incentivan el pensamiento computacional, como Scratch.

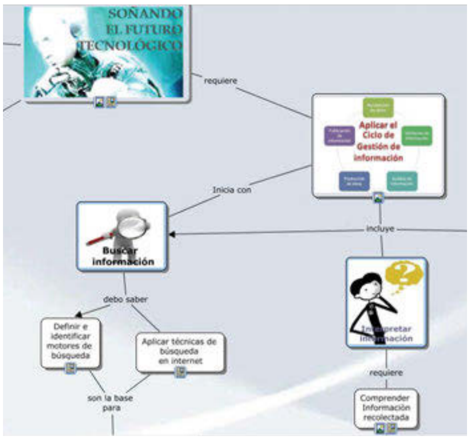

Figura 2. Vista parcial de Itinerario para el proyecto Soñando el futuro tecnológico - Fuente propia
http://mapas.futurodigital.org:8080/rid=1N6ZJRZFV-18W071Q-9G/Gesti%C3%B3n%20de%20la%20informaci%C3%B3n-primaria.cmap

Las guías incluidas en el itinerario y los objetos de aprendizaje son adaptaciones del trabajo que la docente hacía en el aula y demuestran su experticia en la orientación de estos procesos. El itinerario diseñado apoya el desarrollo de competencias de comprensión e interpretación textual en donde se busca que el estudiante analice diversos tipos de texto, utilizando algunas estrategias de búsqueda, organización y almacenamiento de la información y competencias de producción textual que requiere la creación de textos escritos que responden a diversas necesidades comunicativas y que siguen un procedimiento estratégico para su elaboración (MEN, 2004).

Este itinerario se integra por sus saberes, actividades y productos con las áreas de Tecnología e informática y con educación artística. La metodología seleccionada por la profesora, fue la de proyectos colaborativos, para lo cual el itinerario incluye los contenidos y guías necesarios. Los estudiantes asumen el control de su avance dentro del itinerario. Hay autonomía pero aún hay que ayudar con algunas herramientas de autocontrol para que no se distraigan. Se genera también entre los niños un ambiente de colaboración y complicidad, en donde los estudiantes buscan el apoyo de los que ya han desarrollado algunas acciones para que les expliquen.

Construir una herramienta sobre el pasado, presente y futuro de un artefacto tecnológico, usando la herramienta scratch, se convierte en la evidencia de las competencias adquiridas. Además durante el desarrollo del itinerario se realizó un proceso de coevaluación y de autoevaluación, este último a través del cuadro de autocontrol.

Aspectos Significativos y Reacción

En los estudiantes de quinto grado se pudo evidenciar mayor grado de autonomía. El trabajo colaborativo fue un aspecto a resaltar, no solo en el proyecto que se dirigía desde el itinerario, sino, además, desde el apoyo entre pares para aconsejar por donde ir avanzando, como resolver una dificultad o como desarrollar una guía. En esta institución se ha logrado hacer un trabajo con mapas conceptuales y con itinerarios desde diferentes grados y áreas, es así como ya otros docentes están formándose en el tema, aplicando los itinerarios que se han construido y organizando equipos de trabajo para diseñar otros.

4.4 Estudio de caso 4: nivel básica secundaria - Nombre de la experiencia: Construyendo mi proyecto de vida

Este itinerario se desarrolla en la sede principal de la Institución Educativa Gabriel García Márquez, de la comuna 8 de Medellín (Barrio Caicedo) descrita ya en el caso número 3. Se trabajó con el grado 9º que corresponde al nivel de educación básica secundaria, con tres grupos, de edades entre los 14 y los 16 años de edad, los grupos tienen un promedio de 39 estudiantes, para un total de 116. Ellos tienen experiencia con el trabajo con mapas conceptuales por lo cual se logra un buen nivel de motivación y de apropiación. Las dos docentes participantes son del área de tecnología e informática para la básica secundaria y la media técnica, por lo tanto, tienen competencias pedagógicas y técnicas para el manejo de la TIC.

Para este caso se diseñó con las docentes un itinerario orientado a las áreas de Tecnología e informática y Emprendimiento: "Construir mi proyecto de vida", con el cual se busca utilizar herramientas informáticas y aplicar el ciclo de gestión de la información (Figura 3).

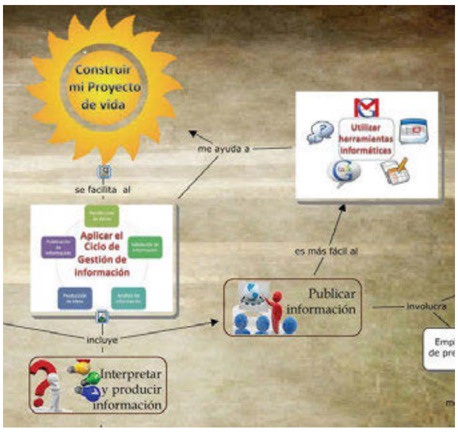

Figura 3. Vista parcial 1 de Itinerario para el proyecto Construir mi proyecto de vida - Fuente propiahttp://mapas.futurodigital.org:8080/rid=1NPZ8PTFV-KGWKHP-J4/Proyecto%20de%20vida.cmap

La situación de las docentes de este caso es especial, pues hicieron parte de la primera experiencia con itinerarios (Agudelo y Salinas,2013), por lo cual ya habían vivido la implementación de esta metodología. El itinerario aplicado ya está en una tercera versión y son ellas mismas las que han ido reorganizándolo. Las guías y objetos de aprendizaje y otros recursos como la zona de recreo son aportes realizados por ellas a través de su propia experiencia.

Aspectos Significativos y Reacción

Las interacciones en el aula estuvieron marcadas por los procesos de asesoría entre los compañeros y algunas veces con su profesora. Los espacios virtuales fueron muy útiles para la asesoría y la coevaluación de los trabajos de los demás estudiantes. La flexibilidad del diseño permitió que los estudiantes tuvieran acceso a diversidad de herramientas que fueron enriqueciendo desde el apoyo entre pares para aconsejar por donde ir avanzando, que herramienta usar o como desarrollar una guía. El diseño de su proyecto de vida como un primer acercamiento a la definición de un futuro personal y profesional marcó el aspecto más significativo del proceso.

4.5 *Estudio de caso 5: nivel universitario - Nombre de la experiencia: Seminario de síntesis*

La Universidad EAFIT es una universidad privada de la ciudad de Medellín que tiene la misión de contribuir al progreso social, económico, científico y cultural del país, mediante el desarrollo de programas de pregrado y de posgrado -en un ambiente de pluralismo ideológico y de excelencia académica- para la formación de personas competentes internacionalmente. (Universidad EAFIT, 2016).

Dentro de sus escuelas de formación, se encuentra la escuela de Administración, la cual ha alcanzado logros importantes como estar entre las mejores escuelas de negocios del mundo. Una de las materias que se imparten en esta escuela es Seminario de Síntesis, ofrecida a estudiantes de último semestre y la cual se convierte en el contexto para este caso de estudio. Esta asignatura se matricula cuando han terminado todas las asignaturas para obtener su título y han finalizado la práctica profesional, por lo que se centra en contrastar la teoría con lo que encontraron en el proceso de práctica, son estudiantes ansiosos por graduarse y son críticos del proceso de formación que recibieron.

Se trabajó con un grupo de 5 docentes de la Escuela de Administración, encargado del área y encabezado por la coordinadora del programa. Los estudiantes impactados en el proceso fueron 450 de 12 grupos, cuyas edades oscilan entre los 22 y los 30 años de edad, los grupos tienen un promedio de 37 estudiantes, para un total de 450. En general, la población de la institución, es de un estrato socioeconómico medio alto, y muchos de ellos ya laboran, por lo que cuentan con recursos tecnológicos para apoyar su proceso educativo.

Se diseñó con los docentes un itinerario que gira en torno a la competencia Identidad del administrador (Figura 4), con la cual se busca: Definir la identidad profesional como administrador en el contexto organizacional con las implicaciones de su gestión en el ámbito social. Es una propuesta de un trabajo colaborativo entre los docentes de la asignatura y obligó a un encuentro de saberes entre ellos. Los docentes por su cuenta continuaron reuniéndose, evaluando, aplicando y rediseñando el itinerario que ya tiene una versión 3.

Dado el contexto y las características de los estudiantes, el itinerario se desarrolla de manera autónoma y flexible lo cual les permite avanzar a su ritmo y de acuerdo a sus intereses y habilidades, incluso en tiempo extracurricular ya que tienen acceso a los recursos desde cualquier lugar y en cualquier momento. Aunque por cuestiones de políticas institucionales, se establecen tres puntos de encuentro para evaluar y reportar calificaciones, cumpliendo con los parámetros de la universidad. Todas las normas y acuerdos están dentro del mismo itinerario y se consolidan en un contrato pedagógico. Los estudiantes asumen el control de su propio aprendizaje dentro del itinerario. En este caso la presencialidad no es obligatoria, por lo cual los estudiantes pueden optar por asistir o avanzar por su cuenta en el itinerario.

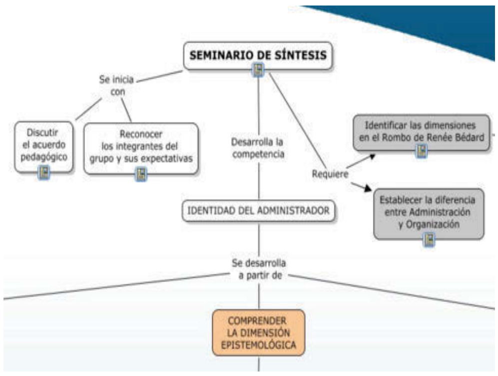

Figura 4. Vista parcial 1 del itinerario Seminario de síntesis V3-Fuente propia http://mapas.futurodigital.org:8080/rid=1N8YWM5J5-7G0W9B-1BS/Seminario%20de%20S%C3%ADntesis%202014-2.cmap

La participación en espacios virtuales es muy frecuente, así como las actividades individuales. El trabajo dentro del itinerario en la versión 3 se enriqueció con el uso de TIC: herramientas ofimáticas, herramientas en línea, espacios virtuales, videos, líneas de tiempo documentos y fichas, elaborados o seleccionados por las docentes quienes tuvieron en cuenta la evaluación de las implementaciones anteriores.

Aspectos Significativos y Reacción

Los aspectos significativos en este caso se remiten a la flexibilidad del itinerario y la forma como los estudiantes asumen la autonomía sobre su aprendizaje y sobre todo a los logros en la gestión curricular por parte del grupo de docentes que lograron trabajar colaborativamente y poner toda su experticia a disposición del proceso de aprendizaje de los estudiantes.

Los docentes sistematizaron su experiencia con los itinerarios flexibles y realizaron un café temático con directivos y profesores de la universidad de diferentes escuelas, socializándola como buena práctica y recibiendo retroalimentación para seguir trabajando con los itinerarios (https://www.youtube.com/watch?v=l-LRXYE8rKQ).

4.6 Estudio de caso 6: educación continua - Nombre de la experiencia: Mapeando en el aula

La Secretaría de Educación de Medellín tiene como misión direccionar el modelo educativo de la ciudad; posibilitar la formación de ciudadanos solidarios frente a la construcción de una sociedad democrática y de plena convivencia; y velar por la prestación de un servicio educativo de alta calidad y pertinencia social (Alcaldía de Medellín, 2016). Tiene a su cargo 217 instituciones educativas de carácter oficial y en su planta de cargos cobija a unos 12 mil docentes.

El proceso de uso y apropiación de TIC de la Secretaría de Educación de Medellín, es un espacio para la generación de conocimientos, nuevas prácticas educativas y el desarrollo personal y profesional, a partir de procesos de investigación, formación, fortalecimiento de las competencias digitales y transformación de los ambientes de aprendizaje, con el fin de apoyar de forma eficiente y efectiva la formación de los ciudadanos del siglo XXI. Promover ambientes y medios de aprendizaje pertinentes e innovadores, en los que se integre el uso de TIC, y que permitan desarrollar el potencial y las competencias de los estudiantes y ciudadanos en general, es su objetivo principal, el cual se logra a partir de diferentes acciones, entre ellas: La formación de docentes.

Para los docentes es claro que las diversas aplicaciones de los mapas conceptuales permiten a los estudiantes de todos los niveles el desarrollo de habilidades cognitivas y aprendizaje significativo en los procesos académicos. Es por ello que se planteó un proceso de formación para docentes de diferentes áreas a partir de itinerarios flexibles que busca responder a la pregunta. ¿Cómo usar mapas conceptuales en el aula de clase?

Los 25 docentes participantes de este caso son profesionales de todas las áreas, con formación en pregrado del área que orientan y en pedagogía. Sus competencias en el uso y apropiación de TIC son muy heterogéneas. Ellos impactaron a la vez a sus estudiantes, unos 850, pues el proceso de formación incluye trabajo in situ. Para este caso se tomó como base un itinerario que diseñó Cañas (2015), cuyo principal objetivo es orientar a las personas que no tienen mucha experiencia en la elaboración de mapas conceptuales.

Dado que el diseño es para todas las personas, se le realizaron ajustes para que, dirigido a docentes, pueda impactar directamente en las aulas de clase. El itinerario se dispone virtualmente en cmap cloud (Figura 5).

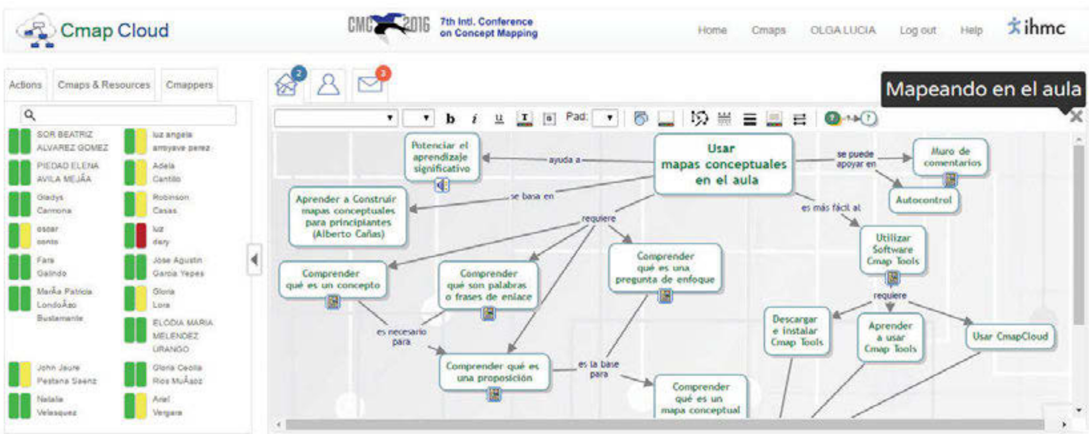

Figura 5. Espacio de trabajo para los docentes en cmapcloud- Fuente propia https://cmapcloud.ihmc.us/cmaps/myCmaps.html#

Aspectos Significativos y Reacción

Surgieron propuestas que lograron mejorar no solo la motivación, sino, además, la estructura de las construcciones conceptuales de los estudiantes, aportando respuestas a la pregunta: ¿Cómo usar mapas conceptuales en el aula de clase con estudiantes de educación secundaria y media? confirmando que el trabajo con mapas conceptuales desarrolla y fortalece las Competencias del siglo XXI, (Ananiadou, K., y Claro, M. , 2010). Se está trabajando en una nueva versión a partir de la experiencia y se espera trabajar en el segundo semestre 2016 con un nuevo grupo de docentes. Los docentes que desarrollaron este proceso y otros que trabajan ya con mapas conceptuales muestran motivación por crear sus propios itinerarios. Con ellos se prepara el material guía para hacer itinerarios flexibles de aprendizaje (Ver https://www.youtube.com/watch?v=x4vCWtM_mfQ).

5 Seguimiento de las experiencias

5.1 Recolección de Información

Para hacer seguimiento, así como para recolectar datos frente a los resultados de las experiencias, en cada uno de los casos se aplican las siguientes técnicas e instrumentos de recolección de información:
La observación: Permite obtener datos de manera directa sobre los casos de estudio y será utilizada por los docentes a cargo de los grupos, empleando el procedimiento de la "observación participante.
La encuesta: Se emplea como técnica mediante un instrumento como el cuestionario que se aplica a estudiantes.
- ***La entrevista:*** Se desarrollan entrevistas grupales con docentes y estudiantes que participan de las experiencias,

Mesas de trabajo: Se realizan con expertos que revisan cada uno de los itinerarios.
Triangulación : Una vez implementados los casos, se tomarán todos los datos, recogidos a través de diferentes mecanismos (observación, encuestas y entrevistas, mesas de trabajo), haciendo un análisis por separado y posteriormente una triangulación a través de una matriz que permita priorizar la información más relevante y los aspectos en que confluyen todos los actores a través de los diferentes mecanismos de recolección de información.

5.2 Avance en los Resultados

Con la información obtenida en los casos de estudio, a través de las encuestas, las entrevistas, la observación participante y las mesas de trabajo, se realiza la triangulación de resultados y se consolidan en la Tabla 2 los elementos aplicables a una propuesta para diseñar e implementar en el aula los itinerarios flexibles de aprendizaje basados en mapas conceptuales.

Se determinan los elementos comunes, los diferenciadores, los elementos relevantes para cada caso y las características aplicables para el modelo de ambiente de aprendizaje que se propone para el trabajo con itinerarios flexibles basados en mapas conceptuales.

Los datos recogidos se registran en una matriz de Excel y se categorizan. En la triangulación de información se determinan frecuencias que permiten combinar y comparar los resultados cualitativos y cuantitativos de donde surgen también unos principios (Tabla 3) y la argumentación de su pertinencia dentro del modelo.

Los principios son discutidos en las mesas de trabajo en donde se priorizaron y definieron algunos de ellos, que se espera presentarlos en una propuesta del modelo de ambiente de aprendizaje ideal para la implementación de los itinerarios. Este proceso ayuda a orientar y enriquecer la investigación.

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Casos de estudio	*Elementos comunes*	*Elementos diferenciadores*	*Elementos relevantes*	*Características aplicables*
Caso 1	• Aprendizaje autónomo • Flexibilidad • Trabajo extracurricular • Apoyo de TIC • Oportunidades para elegir actividades y herramientas • Ambiente de aprendizaje b-learning	• Trabajo con la comunidad • Guías apoyadas por videos • Socialización de entregables en todo el colegio	• Vinculación de padres de familia y otras personas de la comunidad	• Guías con multimedia • Vinculación con la comunidad • Socialización de entregables
Caso 2		• Poco trabajo con Computadores • Gestión de recursos en el aula	• Ambientes de aprendizaje físicos y virtuales para apoyar el itinerario	• Diseñar el espacio físico y virtual como ambiente de aprendizaje para el itinerario
Caso 3		• Trabajo colaborativo y apoyo entre pares	• Espacios virtuales de acompañamiento y socialización	• Foro de asesoría • Espacio de socialización • Trabajo colaborativo
Caso 4		• Apoyo entre pares • Producción individual • Autocontrol	• Autonomía • Clara definición de la competencia	• Cuadro de autocontrol • Definición de la competencia
Caso 5		• Trabajo colaborativo entre docentes	• Flexibilidad en estrategias, opciones de entregables, secuencias	• Diseño entre varios docentes, proponiendo opciones de actividades y entregables
Caso 6		• Itinerario en cmap cloud • Trabajo en situ con estudiantes	• Trabajo en línea con herramientas web 2.0	• Actividades prácticas con reporte en espacios virtuales • Uso de plataformas que brinden herramientas de colaboración

Tabla 2: Triangulación de resultados a partir de casos de estudio

Para el diseño		*Para la implementación*	
	Orientación Flexibilidad Claridad Coherencia		Flexibilidad Interactividad Dinamismo Colaboración
Experticia de los docentes Motivación al aprendizaje Reusabilidad		Responsabilidad Autocontrol Autoaprendizaje	

Tabla 3: Principios para el diseño e implementación de itinerarios flexibles de aprendizaje

6 Conclusiones

Según RAE (2014), un sistema es un conjunto de cosas, de elementos que relacionados entre sí, contribuyen a determinado objeto. Adoptando los itinerarios flexibles de aprendizaje basados en mapas conceptuales como sistema, con este proyecto se pretende caracterizar los elementos que forman parte del ambiente de aprendizaje en el que se desarrollan las experiencias y las interacciones que se dan en su implementación, basado en teorías pedagógicas como la teoría de la asimilación, el aprendizaje significativo y con un enfoque constructivista orientado por los modelos pedagógicos emergentes y sus tendencias para la educación del siglo XXI.

Propósito formativo, contenidos, metodología, interacciones, tiempo y espacio, Rol del docente, rol del estudiante, recursos, seguimiento y evaluación, son los elementos que conforman el sistema y que se han caracterizado gracias al diseño e implementación de los seis casos que se presentan en este paper.

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LEXICAL CATEGORIES: CONCEPT MAPPING INSTRUCTION ON THE EFFECT OF NOUN IDENTIFICATION IN FOREIGN LANGUAGE TEXTS

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Abstract. Concept maps basic training differences were examined in noun identification from written texts, in the context of reading and writing assignments in a foreign language. Sample groups were comprised of 10-year-old Spanish primary students who attend a bilingual school. Both male and female participants were included in the non-randomized experiment. Experimental and control sample groups were accurate in identifying singular and collective nouns, including plural irregular nouns. Although the trained sample group was efficient in detecting and categorising hypernyms and first hyponyms, compared to lower hyponym categories, pupils did not precisely discriminate adjectives within the texts, sometimes confusing them with nouns. In contrast, while the non-trained sample group disclosed precision in circling nouns and discriminating adjectives within the texts, they demonstrated less precision identifying other grammatical categories. The control sample group did not reveal accuracy discriminating verbs, adverbs, and pronouns from nouns when compared to the experimental group. Because of their lack of training, the control group displayed more creativity (charts, mind maps, tree diagrams…) when asked to create concept maps, in comparison to the experimental group. However, the trained group accomplished this activity satisfactorily. The outcome of this study reveals that a three-month trained concept mapping sample group disclose achievement in discriminating specific information from English texts. These conclusions suggest that concept mapping helps students differentiate lexical and grammatical categories from written foreign texts, which will benefit them when synthesizing the information to be learned.

1 Introduction

Natural Science books for Spanish primary students learning curricular content in foreign languages[1] (L2) are overloaded with technical information comprehending new concepts students must learn[2]. Teachers, by means of didactic transposition and instructional techniques, disclose the important information pupils need to be aware of. In some circumstances, teachers show students how to handle those concepts, as well as how hypernyms enclose hyponyms and how words are linked and hierarchized within texts. For that purpose, concept maps are efficient support for teachers when giving those explanations. But because of lack of time and class resources, or further reasons, it is not always feasible to teach pupils how to handle information themselves: “The extraction, selection, and prioritizing of concepts from information-dense material are often-overlooked skills vital to *culling out* [emphasis added] extraneous material” (Mintzes, J., Wandersee, J., & Novak, J., 1998, p. 116). Taking this into account, the purpose of this research is to establish a first contact, from a series, with concept maps for those Spanish primary students learning curricular content in English. That is to say, studying at bilingual schools.

Considering all of the above, the objective of this study is to monitor if students trained briefly in concept map usage are able to discern specific information from English texts in a more efficient way than non-trained peers. The reason we consider discrimination of information at this age as stage-important is that it might affect present and future students’ knowledge and final marks when learning curricular content in L2. The tool we propose to facilitate this is the use of concept maps. We also consider that both learning curricular content in L2 and managing concept maps demand high order thinking skills from primary students. This variable was observed in this study, causing more stress in the experimental group than in the control group because of the extra, unknown, demanding homework needed when using concept maps. For this reason, when teaching the use of concept maps to primary students, we also suggest a step-by-step concept mapping instruction from the very beginning, as well as giving pupils time to develop their skills in the use of this helpful tool. Therefore, the hypothesis inferred is that a three-month-trained experimental group will discern nouns from English texts more efficiently than non-trained students belonging to the control group. As a result, they will summarize more proficiently the information to be learned.

When acquiring knowledge in an L2, it is generally beneficial for students to summarize the curricular content managed, especially the specific information to be recalled when sitting an exam. Summarization includes using mind processes, language interpretation, and narrating (Kay, C., Roberts, J., Samuels, M., Wotherspoon, I., 2009). In summarizing content, summarists have to know how briefly to restate the essence of a text in a new and personal manner (Figure 1a & b shows pupil’s concept maps and summary[3]). In order to support learning and organise information, most CLIL (content and language integrated learning) teachers use multi-media and visual organisers

[1] In applied linguistics, L1 designates first language, native language, or mother tongue; L2 designates a speaker’s second/foreign language.
[2] Yeast, sprain, taste bud, petiole, prickly, thorn, hedgehog, steppe, egret, sewage, sieve, dam, axle, fulcrum, plug, pulley…
[3] Ten/eleven years old participants in this study made all of the concept maps included (with permission) in this article.

(Bentley, 2013). Regarding summarization, including the above mentioned culling out skills to be taught to pupils, teaching techniques to summarize are not commonly developed in the average classroom. However, research shows that summarizing facilitates learner comprehension and long-term retention of information (Wormeli, 2005). Our premise is that gradation when summarizing, from lexical categories to summaries, by means of concept mapping is significant.

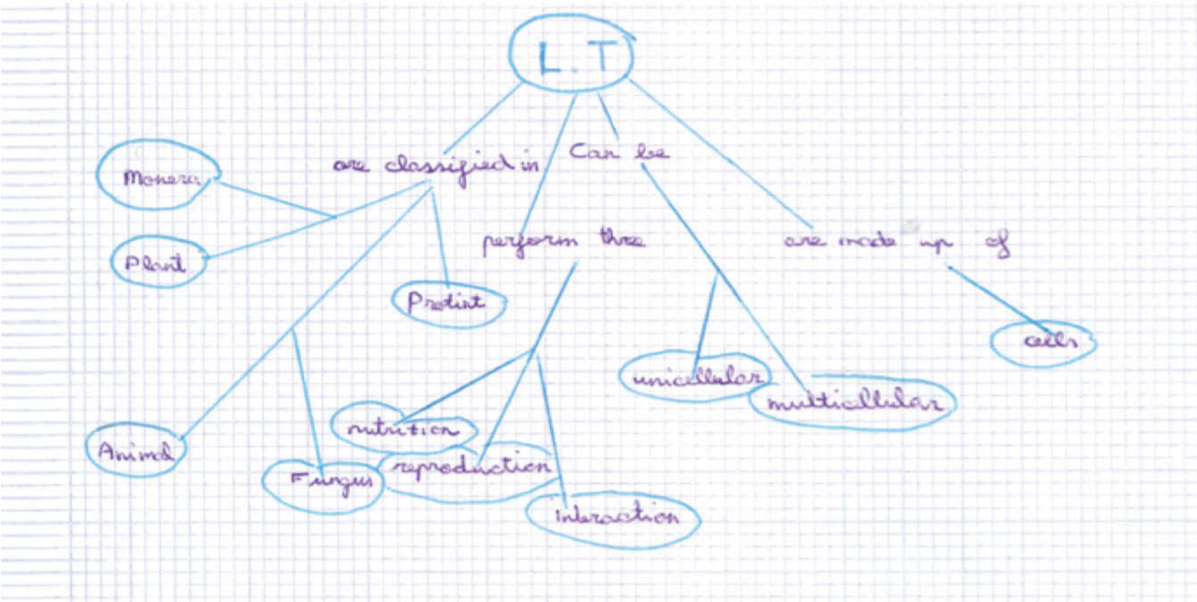

Figure 1a. Concept map made by María Santurino, a two-month-trained student.

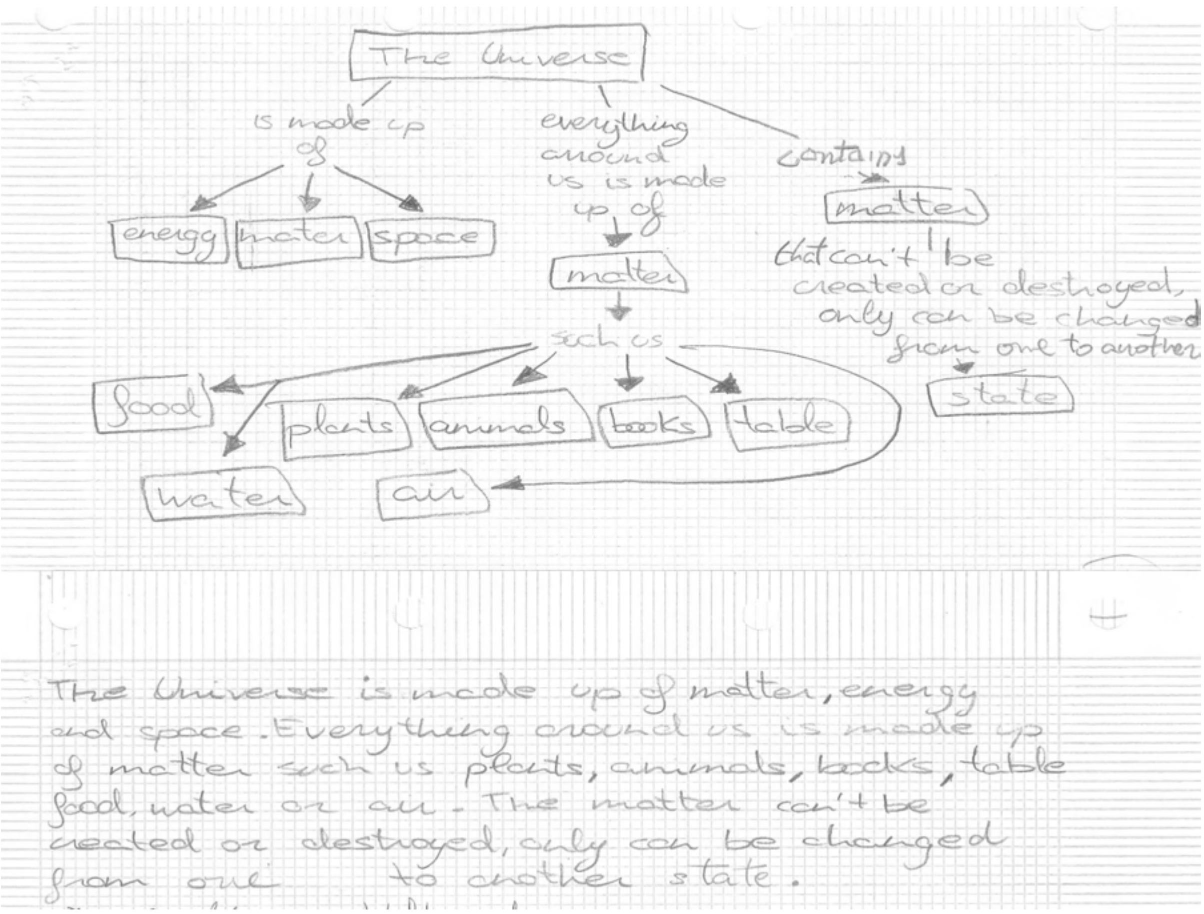

Figure 1b. Concept map and summary made by Jesús Marcos Valhondo, a six-month-trained student.

Text comprehension in a language includes the knowledge of basic grammatical lexical categories. Furthermore, this grammar affects the way reality is perceived. Each personal view of the world is dependent on the language structure of the speaker allied to a language (Seuren, 2013). This grammatical-individual interpretation of reality implies biological matters as well, for example brain development. In some cases, both grammatical awareness and biological development represent barriers to foreigners when interpreting and summarizing curricular content in a foreign language. This occurs especially in early ages, when teachers at bilingual schools teach subjects other than English, in English, to non-native speakers. There are also external barriers for pupils to deal with, such as relatives who cannot properly help these pupils to finish their homework because they themselves are not bilingual.

Spanish primary students' misinterpretation of English texts diminishes their comprehension and long-term retention of curricular knowledge, even if they summarize the information. For that reason, the use of concept maps is highly recommended in education from early ages (Novak, 2010). To begin teaching usage of concept maps to non-English speakers, it is reasonable to initiate the instruction of pupils to the English-essential grammatical lexical categories, especially nouns. To illustrate this, in previous research where participants were requested to recall isolated words, the scores were higher for noun recognition than for verb keyword groups. An explanation for this phenomenon is as follows: "A plausible cause of this effect of grammatical class is that the referents of verbs are harder to imagine than those concrete nouns (. . . .) more effective keywords than verbs" (de Groot, 2011, p. 97). Although in this study both groups identified most of the nouns within the four texts, they showed dissimilar results when confusing other grammatical categories as nouns. For example, the experimental group identified adjectives as nouns, whereas the control group identified verbs, pronouns, prepositions, conjunctions, and adverbs (mainly grammatical categories other than adjectives), as nouns.

To identify lexical categories, nouns within texts, pupils focus attention on two linguistic aspects: grammatical structure, and translation of words to recognize their meanings and semantic fields. Structurally, students segment texts by scrutinising the syntax to identify words according to their position within the sentence. This is not an easy task for primary pupils. They identify, underline, highlight, or extract each word categorizing the grammatical structure and word functions. Semantically, children associate words with their meanings by means of looking for their denotative significances in bilingual or monolingual dictionaries. They also request translation from peers and teachers. In some circumstances, "When children are beginning to discover written [foreign] language, helpful adults often act as mediators by saying what the printed words are, leaving to the child the more complex task of [grammatically] discovering how to distinguish one word from another" (Smith, 2004, p. 132).

As a consequence, pupils that commonly use concept maps to deal with information are supposed to effortlessly identify word categories within natural science texts. This instruction makes them aware that word functions are different. They are conscious that nouns are dissimilar to the rest of the grammatical words because they are words enclosed within boxes in the concept map frame. They understand that, when those concepts are placed in order, some words are more inclusive than others. Instructed pupils also discern that those concepts are connected to each other by means of linkers, which contain different word categories other than concepts (Novak, 1988). Undoubtedly, the more prior knowledge pupils have about the curricular content, the easier it is for them to identify nouns and other lexical categories within a text, thus easier to acquire more significant learning (Ausubel, 1968). But to learn new curricular content in a foreign language can be confusing for students whose English level is below the lexical-grammatical content in their class books, unless they have previously been trained in the use of concept maps.

A clearer example can be seen below (Figure 2a & b), where a trained and a non-trained students in the use of concept maps were asked to do task one[4] from text D. This consisted of making a concept map from an approximately 158-word text, including the title and headings. Both groups performed this task at the same time and none of them, in theory, had had previous knowledge about the curricular content. While doing the task, they were not allowed to ask teachers or classmates for help, or use a dictionary. As a result, the three-month trained student in the use of concept maps appropriately encloses concepts, but still identifies some adjectives as nouns. A reasonable explanation for this could be that the headings they had been using to make concept maps from their class books (large letters and green or black bold print) were normally made up of two or more words, usually composed of an adjective and a noun (***Living** Things*) but sometimes included other grammatical categories of words (*Parts **of** Plants*). Similarly, the non-trained student chooses nouns and adjectives as hypernyms, but chooses a different visual organizer and adds extra words in it.

[4] A more detailed explanation of the activities is given in *2.2 Materials and procedure.*

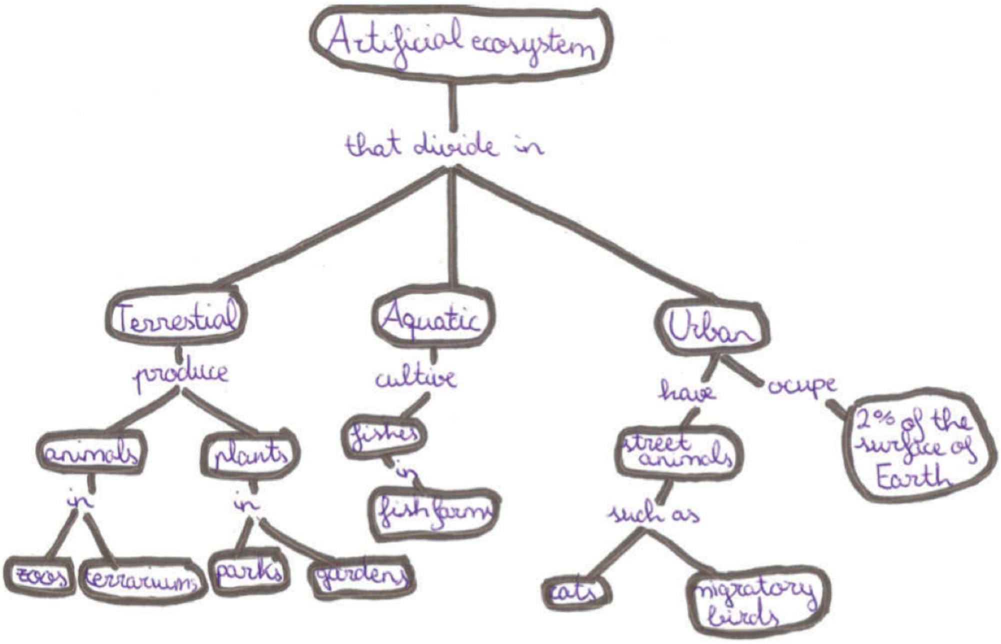

Figure 2a. Three-month-trained student's creation when asked to make a concept map from task D1 (by Mateo Jiménez).

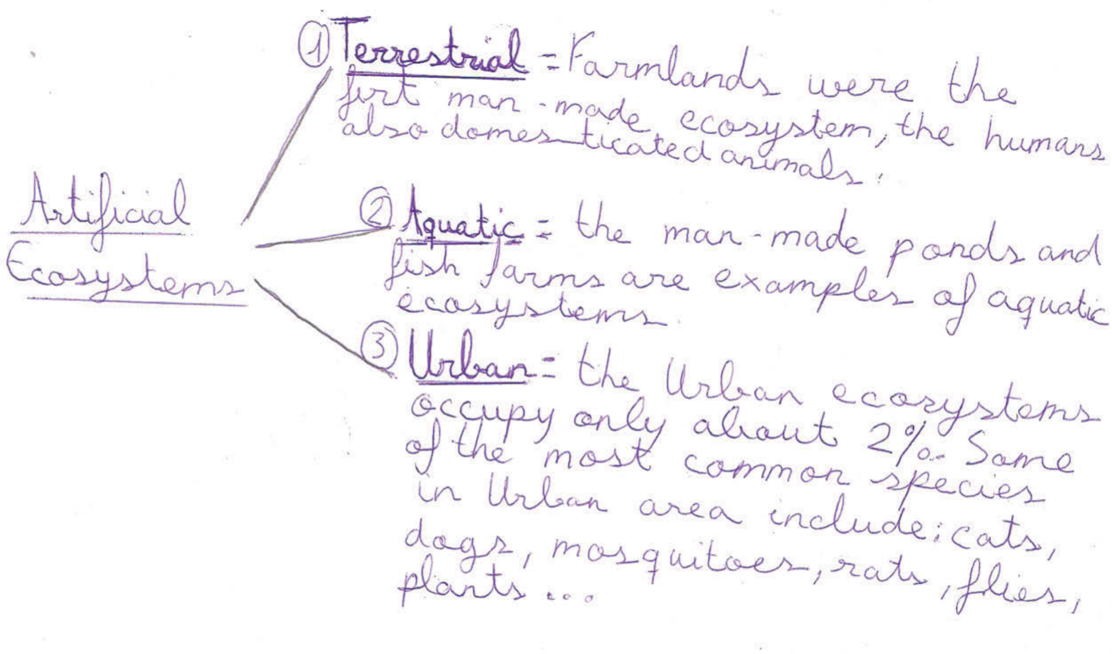

Figure 2b. Non-trained student's creation when asked to make a concept map from task D1 (by Cayetana Durán).

2 Method

This experiment consists of a quantitative research. By means of noun identification within written English texts, we aim to determine concept mapping trained students' comprehension and abstraction. We have designed a post-test case study in which a formative teaching has been applied to one of the analysed groups. The analysis is descriptive, to provide the analysed students' profile. This contingency analysis, or crosstabs, allows us to establish a relational level between variables. Finally, the average comparative analysis will show the difference existing between the two groups, the experimental and the control ones.

For counting and for evaluation of the detected nouns and non-nouns, we have used three equal intervals, based on the selected nouns' rank according to each of the fulfilled activities. We have gradually named these intervals so that correct answers and errors can easily be identified.

Correct intervals are identified as follows:

- Excellent = 3/3
- Good = 2/3
- Developing = 1/3

Error intervals are identified as follows:

- Excellent = 3/3 errors
- Good = 2/3 errors
- Developing = 1/3 errors

Observe that error intervals are the opposite of correct answer interval, the fewer the errors (developing) the better the result.

2.1 *Participants*

Two equivalent groups of subjects–experimental (n = 30) and control (n = 30)–differently treated. Sample groups consisted of fifth-grade student, all Spanish-language speakers, aging between 10-11 (M_{age} = 10.5), selected from a bilingual school located in Castilla-La Mancha, Spain. Experimental (male = 19; female = 11) and control (male = 20; female = 10) groups were randomly assigned. Yet, individuals belonging to each group were not randomly assigned. In the table below (Figure 3) percentages of representation (males and females) belonging to each group, and collectively, can be seen. They were unmodified, naturally existing groups: two fifth grade classes. Groups did not significantly differ in any incidental characteristic. However, a special-need pupil coexisted in the experimental group during the experiment. Tasks for this participant were translated into Spanish. Another particularity is that a slightly higher subject mark average from the previous school year was observed in the control group (0.4), compared to the experimental group. 100% of the group members participated in the experiment.

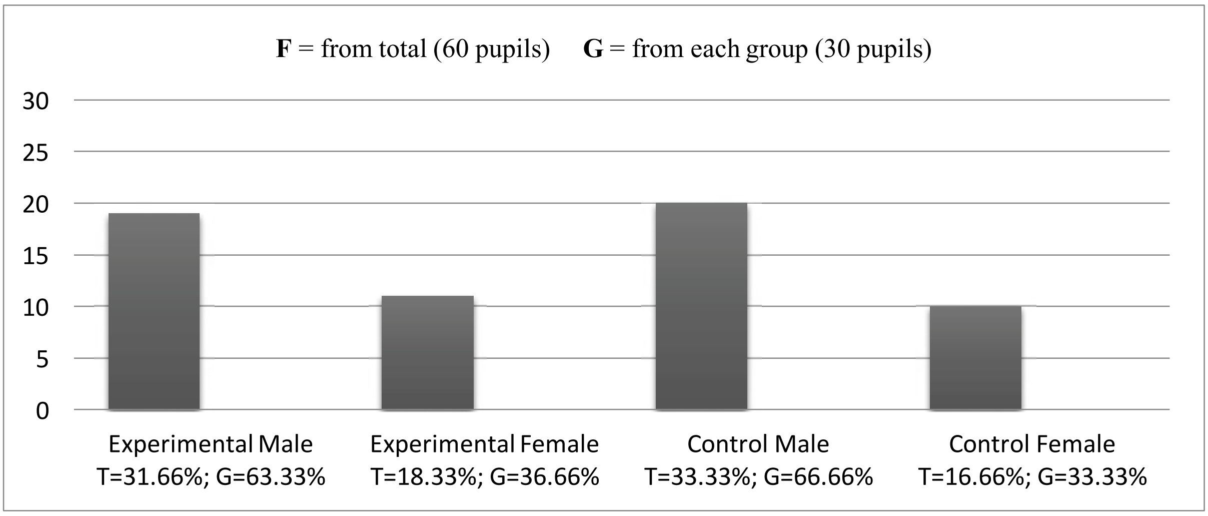

Figure 3. Experimental & control percentage representation (male, female, per group, total and partial in both groups).

2.2 *Materials and procedure*

Four texts were adapted from the pupils' *Natural Science* book (Riach M. and Bacon T., 2014), whose curricular content is based on the Castilla-La Mancha 54/2014 Decree. The reason these texts were chosen from this book is because it is the textbook that both groups were using during the 2015-2016 school year. Curricular content belongs to Unit 5, "Ecosystems". This unit was being taught during the same period of time when the experiment took place. This encompasses pages 68 to 73 of the book[5]. The text format, adapted for the experiment, was the same as the textbook format, but drawings and other noun-identification facilitators were omitted. Highlighted and bold print within the task texts was also deliberately excluded. Only titles, paragraph headings, and some hypernyms appeared in bold within the task texts for reference purposes. Texts were written in English but, to facilitate students' understanding, instructions in Spanish were included (Figure 4 shows an example of task instructions).

ACTIVITY (do it in English and step by step):
1. You can use either a pen or a pencil. You can also underline, highlight, or write on the paper. 2. Write your name, date, grade, and group you belong to. 3. Answer this question: Do you attend extra particular classes other than English? YES ☐ NO ☐ 4. Make a concept map from the reading. You cannot ask for help to your teacher or classmates. You are not allowed to use a dictionary.

Figure 4. Tasks instructions were given in Spanish. The instructions above belong to task one, text D (D1).

Assignments consisted of four readings with two tasks to perform in each, 8 tasks total. Tasks 1 (4) varied from text to text (qualitative); tasks 2 (4) were common to all texts (quantitative). A total of eight tasks or steps were carried out as normal classroom activities, lasting approximately three hours total (T_{average} = 22' 5" per task). The sole purpose of the four task ones (T1) was in order for students to establish a first contact with the curricular content.

Tasks were developed as follow:

1 In the first assignment (T1), students were asked to summarize text A into a paragraph without text translation or explanation. Next, translation and explanation of the text took place with their teacher. Finally, completion of task two (T2), using the same text A, consisted of circling all the nouns within the reading.

2 In the second assignment, text B, students were asked to condense the text for a study purpose without text translation or explanation, as they usually do when summarizing information (T1). Next, they had to describe the process or steps they followed in order to do this task. Finally, translation and explanation of the text took place with their teacher. Then they completed task two (T2), by circling all the nouns from the reading.

3 In the third assignment, pupils were asked to extract the nouns from text C without any translation, explanation, or use of dictionaries (T1). Next, translation and explanation of the same text took place with their teacher. Finally, they completed task two (T2) by circling all the nouns from the same reading C.

4 In the fourth assignment, without text translation or explanation, students were asked to create a concept map of text D (T1). Next, translation and explanation of text D took place with their teacher. Finally, they completed task two (T2) by circling all the nouns from the same text D.

Assignments from texts A, B, C, D, consisted in two tasks per text. This process was always routine (tasks one [T1] consisted of pupils having a first contact with the texts, then translation into Spanish, and finally, tasks two [T2], consisting of circling all the nouns from the texts).

Regarding materials, no special resources were needed. Students were given blank sheets of paper and texts A, B, C, D with the instructions in Spanish, to fulfil each session's tasks. Four different texts were used for the four assignments (A, B, C, D), whose nouns were to be circled by the students during each session–*quantitative* tasks two (T2) named A2, B2, C2, and D2. The additional piece of paper was used to complete *qualitative* tasks one–named A1, B1, C1, and D1. Students were asked to have a pen, pencil, eraser, and coloured pencils on their desks before starting the tasks. To finish qualitative tasks, students belonging to the experimental group asked for extra blank sheets of paper to complete some of the tasks. The vast majority of components in this group had

[5] Because of Copyright none of these pages are included.

difficulties completing the task within the space designated to do tasks B1 (condensing the text for a study purpose in the way they usually did) and D1 (making a concept map), in comparison to the control group.

3 Results

As shown in the next bar chart, in both selected groups male representation was higher (65% male, 35% female from [60] total). All participants are in the same grade and are of similar age (10 to 11 years old [*M* age = 10.5]). There is almost no difference in their extracurricular training classes, with only a slightly higher percentage for those belonging to control group, with the exception of extracurricular English classes (see Figure 5).

Percentage results referring to this aspect are as follow:

Experimental group (some students might attend both classes, English and other subjects, simultaneously)

- 33.3% of the students do not attend extracurricular classes
- 66.6% of the students attend extracurricular English classes
- 20% of the students attend extracurricular non-English subjects (maths, Spanish…)

Control group (some students might attend both classes, English and other subjects, simultaneously)

- 63.3% of the students do not attend extracurricular classes
- 36.6% of the students attend extracurricular English classes
- 23.3% of the students attend extracurricular non-English subjects (maths, Spanish…)

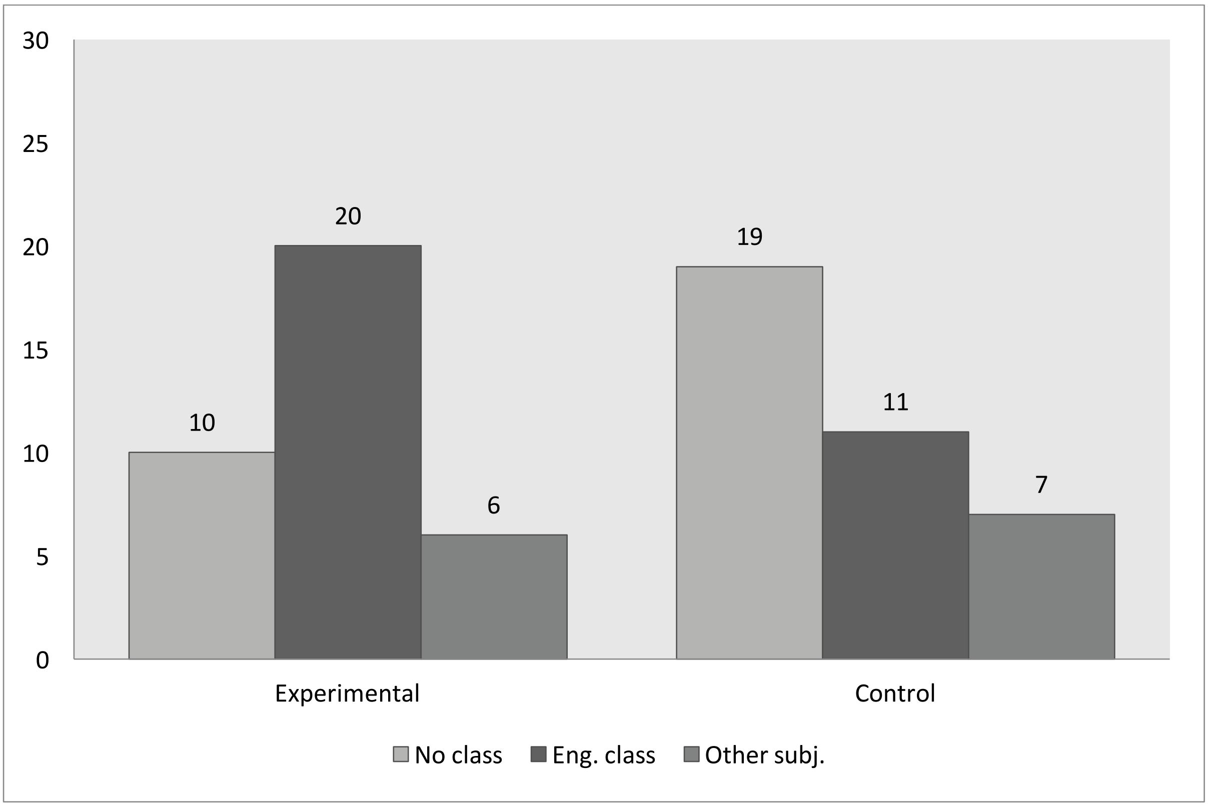

Figure 5. Students per group attending or not to private English, and other subject, classes.

Regarding the results of the four tests, the nouns correctly identified in each text show us that higher percentages are located within the superior interval entitled "excellent" (see Figure 6). Paradoxically, regarding the number of undetected nouns, and thus errors, the majority of both groups tend to be within the higher interval as well, with the exception of the A2 test where they are indeed within the lowest interval. This fact reflects the lower degree of complexity and less number of words, and thus nouns, in the A text.

CORRECT ANSWERS IN:	**Text A2**	**Text B2**	**Text C2**	**Text D2**
Experimental	74.25% 3/3 rank	82.69% 3/3 rank	83.74% 3/3 rank	88.33% 3/3 rank
Control	89.16% 3/3 rank	85.90% 3/3 rank	84.33% 3/3 rank	90.89% 3/3 rank
ERRORS IN:	**Text A2**	**Text B2**	**Text C2**	**Text D2**
Experimental	190 (6.33% = 1/3)	719 (23.96% = 3/3)	694 (23.13% = 3/3)	832 (27.73% = 3/3)
Control	226 (7.53% = 1/3)	768 (25.60% = 3/3)	538 (17.93% = 2/3)	711 (23.70% = 3/3)

Figure 6. Percentages of correct answers and number of errors per group and task.

From the contingency analysis, it can be seen that no significant relationship exists between the gender variable and the correct vs. error variable when identifying nouns, with the signification indicators in the chi-square test above 0.05. These variables in the four tests run have no significant relation to the extracurricular English class variable either, and therefore do not discriminate. The levels of signification also rise above 0.05. The same occurs with the variable group (experimental or control). There is no table with an existing significant relation, and therefore, having been trained to use concept maps during a three-month period of time does not imply having better results in noun identification in either of the texts.

Finally, in the t-test for independent samples, the results give us average results above 2.5. This indicates that noun identification would be in the highest levels in both groups (excellent). The averages of the non-identification of nouns would oscillate in the middle levels. This occurs in both groups. Analyzing the differences in the averages, we can observe that the difference is only significant in the A2 test, with a difference of -0.333 (Figure 7). Here, a distance is established between the groups, favouring the experimental group over the control one. As for the rest of the texts (B2, C2, D2), the differences are not significant. It could be said that there is no difference between the groups. Therefore, we are working with considerably homogenous groups in regards to the number of nouns identified.

	Levene's test for equality of variances			
	F	Sig.	t	Mean differences
Correct answers in A1	43.817	0.000	-2.955	-0.333
Errors in A1	12.900	0.001	-1.680	-0.167
Correct answers in A2	1.225	0.273	-0.548	-0.067
Errors in A2	3.030	0.087	-0.851	-0.067
Correct answers in A3	0.000	1.000	0.000	0.000
Errors in A3	1.927	0.170	1.166	0.167
Correct answers in A4	1.396	0.242	-0.584	-0.033
Errors in A4	1.783	0.187	0.808	0.133

Figure 7. Test statistics.

4 Discussion

Some conclusions can be observed from the obtained results. Firstly, that we are using two almost perfectly homogenous groups in regards to their capability of identifying nouns within the texts, all of them displaying acceptable results. This alone proves true success through training/instruction of concept maps to the experimental group.

The justification is as follows:

- This group started the academic year with a difference of 0.4 average subject marks lower, compared to the control group
- Within the A, B, C, and D texts, these trained students essentially made the mistakes by circling adjectives as nouns, compared to the control group
- To make use of concept maps easier, these pupils were allowed to include within the boxes whole propositions (mainly headings formed by an adjective and a noun)

Due to these factors, the statistical figure given to us in t-test, which shows that there are hardly any differences between the two groups, implies the acquisition of comprehensive and abstraction skills by the experimental group. This means that the experimental group, which had demonstrated a lower academic level before the instruction, was able to obtain the same results as the group having a higher academic level. The results also conclude that neither the gender nor the extracurricular English classes would be variables that discriminate, regarding the number of nouns identified in the tests. Therefore, the level of comprehension is not determined by these variables, confirming that gender does not determine the levels of cognition.

At the methodological level, the discussion could arise about if the division into three intervals is adequate or if, to obtain more accurate information, it would be interesting to increase these intervals to six. Likewise, there is a doubt about whether the execution of the noun discrimination activities within the texts should be before or after text translations and conceptual explanations. Another methodological discussion emerges from whether it is appropriate, at the initial concept-mapping-training stage, to allow pupils to write headings within the concept maps boxes. We found that, at this age, it is very difficult for most of them to identify and extract concepts from a text and then categorize them in hypernyms and hyponyms, and then transcribe the information into a concept map. At the beginning of the concept mapping instruction we tried to do so but finally we decided to allow them to use paragraph headings (generally encompassing adjectives and nouns such as *living things*, *aquatic ecosystems*, *artificial ecosystems*, *coral reefs*, *physical environment*…). This might also have been one of the reasons why the experimental group identified adjectives as nouns. This group accommodates the information that both categories of words are the same. During the experiment none of the groups were taught grammar in the Natural Science class.

From this study, information that we consider relevant for future research has emerged. It can be observed that both groups confuse other lexical and grammatical categories as if they were nouns. On one hand, the three-month-trained experimental group made the most mistakes in identifying adjectives as nouns. In the previous paragraph we have exposed one possible cause for this reason and, in that respect, we think that with some more training they will be quite more accurate when identifying nouns. On the other hand, the control group did not get confused when discriminating nouns from adjectives. Although, what called our attention most is that this group of control made far more serious mistakes. For example, the vast majority of the participants in this group confused, that is to say they circled, what are supposed to be easily recognizable lexical and grammatical categories (verbs, adverbs, pronouns, prepositions, conjunctions…) with nouns.

In conclusion, regarding whether L1, concept mapping has positive effects in text comprehension (Chang, K., Chen, I. & Sung, Y., 2002). In L2, it has also been demonstrated that learners having English as a foreign language who use concept maps have achieved much better learning results that those who did not (Mahnam & Nejadansari, 2012), which means that the use of this worthwhile tool helps students to develop, one way or another, their receptive (reading & listening) or productive (writing & speaking) skills (see Figure 8 [0.04]). When children are developing these skills, during the pre-school/primary education stage, teachers play an important role. For this reason, we suggest some future lines of research, especially to those infant and primary teachers whose pupils are immersed in bilingual programs. First, we think that some more longitudinal research regarding the use of concept maps, from infant education on, would be appropriate. Concept maps provide a wide variety of possibilities to do this. We also consider that including the use of concept maps in the bilingual schools will be beneficial for the vast majority of the students. Finally, we suggest that other researchers at bilingual schools replicate this experiment to the same type of fifth graders, to consider the values outside this measured range to know if the tendency within this range continues outside it when being extrapolated.

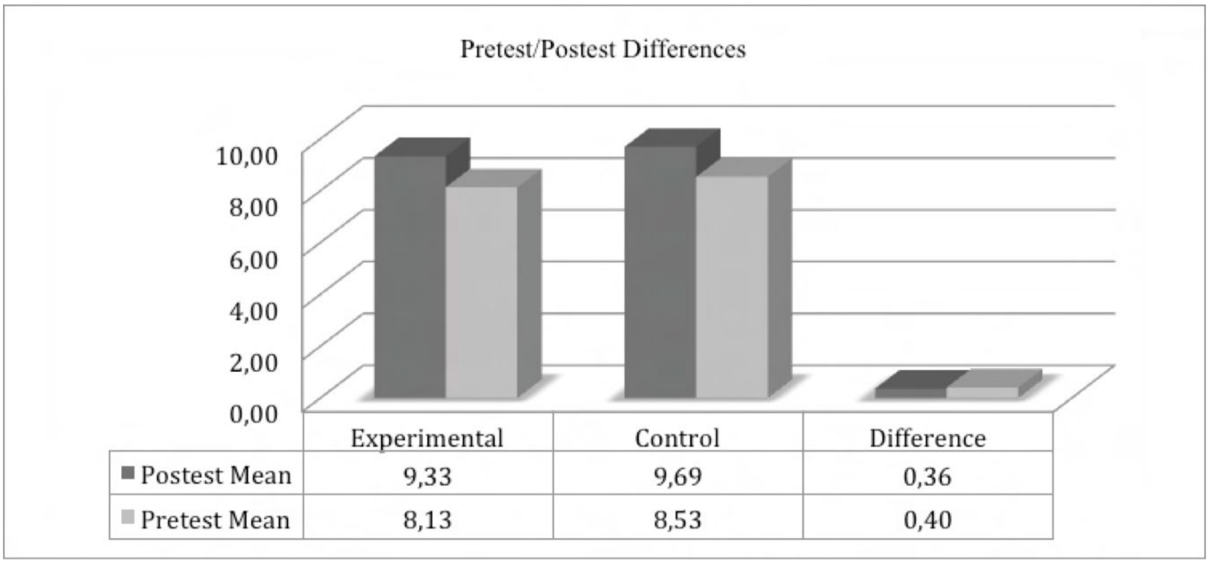

Figure 8. Graphic shows a decreasing difference between groups. Three-month-trained pupils improved their marks in 0.04.

5 Acknowledgements

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MAPAS CONCEPTUALES EN LOS PROCESOS DE INVESTIGACIÓN EDUCATIVA

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Abstract. Este documento presenta un estudio sobre el uso de los mapas conceptuales en una investigación en el campo de educación y bajo un enfoque cualitativo. El mapa conceptual es una poderosa herramienta para facilitar los procesos de enseñanza y aprendizaje en las personas. Su uso se extiende a diversos contextos; educativos y en otras organizaciones. En el campo de la investigación psicológica, el mapa conceptual ha resultado útil en investigaciones cognitivas, en otros contextos los mapas conceptuales se aplican al diseño de sistemas de información, interfaces e hipermedia educativa. En este trabajo se explora una dimensión del mapa conceptual como parte de métodos y herramientas de la investigación: en particular su uso para en los métodos y procedimientos en el análisis de datos cualitativos. En este trabajo describimos la experiencia de elaboración y aplicación de mapas conceptuales en las diferentes etapas de la investigación doctoral cuyo objetivo es conocer concepciones y procesos de la enseñanza y el aprendizaje de quienes participan en la formación artística profesional. En esta ocasión es presenta el avance en el estudio de las concepciones de los profesores universitarios de una Universidad Pública Estatal en México.

1 Introducción

La investigación educativa es un campo interdisciplinario, cuestiones y problemas pueden ser abordados desde distintas disciplinas y métodos, involucrando diversidad de paradigmas y enfoques teóricos (López ,2006). Los objetos de la investigación educativa son construcciones que dan cuenta de los fenómenos educativos y sus escenarios; la investigación puede buscar comprender la naturaleza de los fenómenos, ampliar o profundizar desde distintos enfoques metodológicos, y posiblemente tener la intención de mejorar las realidades educativas, provocar la innovación, orientar la toma de decisiones y proponer nuevas formas de intervención educativa a partir de comprender los procesos de enseñanza y aprendizaje.

El presente trabajo es parte del desarrollo de una investigación educativa doctoral, se centra en las formas de enseñanza y aprendizaje en el proceso de la formación artística profesional en la universidad. El enfoque adoptado es el estudio de las concepciones de los profesores universitarios sobre la enseñanza, la formación, el conocimiento, la evaluación y el aprendizaje, entre otros conceptos. Es un estudio cualitativo con profesores de la Universidad Autónoma de Chiapas, Estado de Chiapas en México.

De acuerdo con Rodríguez, Gil y García (1999) una investigación cualitativa puede desarrollarse a partir de cuatro etapas: **preparatoria** que implica el desarrollo de un proyecto y diseño de investigación, **trabajo de campo** que se relaciona con el acceso al escenario educativo para la recogida de datos, **analítica** donde se realizan los procesos de reducción de datos, codificación y transformación de datos obtenidos en resultados y conclusiones y por último, la etapa **informativa,** en la cual se elabora el informe final de la investigación. En este trabajo nos encontramos actualmente concentrados en la etapa analítica, aunque hace falta una segunda visita de trabajo de campo, la información recabada y el análisis realizado nos permiten ya ofrecer reflexiones y hallazgos en lo metodológico y en la comprensión de las concepciones de los profesores. En particular nos centraremos en documentar y sistematizar el uso de los mapas conceptuales como método y producto del análisis realizado. La aplicación del mapa conceptual abarca el diseño de investigación hasta la presentación de resultados preliminares.

El mapa conceptual es una red de conceptos ordenados jerárquicamente, es decir, que los conceptos de mayor generalidad se presentan en los niveles superiores. Los mapas pueden ser elaborados a partir de un texto para representar su contenido, como herramienta para elaborar notas de clase, ordenar y representar los conocimientos que las personas tienen sobre un tema, o para representar conocimientos y teorías de las disciplinas científicas (Aguilar Tamayo, 2012). La función que se presenta en este artículo se relaciona con la importancia y elaboración de mapas conceptuales en los procesos investigativos, puesto que sirven como una herramienta efectiva para la investigación educativa. (Novak & Gowin, 1988; Aguilar Tamayo, 2012). Sobre todo, en el análisis de información, por ejemplo, en la revisión bibliográfica, construcción del marco teórico y el análisis de datos cualitativos.

Para la etapa preparatoria, se realizó el diseño de la investigación que incluye: delimitar el objeto estudio, articular los métodos de investigación con el marco teórico, y el desarrollo de instrumentos para la recolección de datos entre otros aspectos. Una de las tareas analíticas en la fase preparativa es la comprensión profunda de teorías y conceptos, de manera natural el mapeo de conceptos permite el desarrollo de estrategias analíticas, que fueron complementados con la elaboración de diagramas UVE; herramienta heurística útil para ayudar a las personas a entender la estructura y los procesos de conocimiento (Novak & Gowin, 1988).

La UVE y los mapas conceptuales facilitaron explicitar y detallar los elementos principales de la investigación. En la preparación del trabajo de campo, el mapa conceptual sirvió para representar los ejes y categorías primordiales de los instrumentos de entrevista y observación participante. También para mapear las rutas y procedimientos a seguir en el trabajo de campo. En la etapa analítica se utilizó el software ATLAS. Ti (http://atlasti.com/) con el cual se llevó a cabo el proceso de lectura, codificación y categorización de datos, de este primer análisis surgieron códigos y conceptos principales que fueron mapeados y que permitieron la precisión y detalle en el análisis cualitativo de datos.

2 Metodología

Como punto de partida, se inició con la recolección y revisión bibliográfica sobre temas y conceptos relacionados a la investigación. Los textos recabados pasaron por el proceso de lectura y relectura de manera analítica. En cada texto se fue remarcando y seleccionado ideas y principios relevantes, se tomaron notas y a partir de ahí se obtuvieron los conceptos ejes a mapear, algunos de estos conceptos fueron: *enseñanza*, *aprendizaje*, *profesor universitario*, *formación artística profesional*, *educación superior*, *educación artística*, *etnografía*. Como parte del proceso de análisis los seminarios del programa doctoral ofrecen espacios reflexivos y analíticos, el mapa conceptual fue utilizado también para la toma de notas y tareas en los seminarios.

Otros mapas conceptuales, que implicaron un proceso de integración y generalización fueron aquellos en los que se representa la problemática, unidades de análisis, y algunos vinculados a la elaboración de diagramas UVE para precisar problemas y entender el procedimiento metodológico y su interrelación con las preguntas de investigación. El diagrama de UVE se utilizó como parte de proceso de reflexión y autoevaluación de la propia comprensión de la problemática y el diseño de la investigación, por lo que fueron elaboradas varias versiones de UVE hasta llegar a la versión final con los elementos conceptuales y metodológicos articulados y más apropiados al objeto de la investigación.

Todos los mapas conceptuales se hicieron mediante el software CmapTools (http://cmap.ihmc.us/) que facilita la representación y edición de estos de una manera fácil y agradable (Cañas *et al*. 2004). Hasta aquí, los datos mencionados refieren al uso de mapas conceptuales que sirvieron desde el inicio de la investigación y apoyaron como esquemas generales para conceptualización del marco teórico, problemática, mapeo de conceptos principales y teorías científicas, dicho proceso posibilitó la comprensión de la información y definición de una teoría y método específico en el estudio. Esta primera etapa guió a la siguiente que fue la realización de trabajo de campo. A continuación, se muestran imágenes que refieren a esta primera etapa de mapeo de conceptual y elaboración de diagramas UVE. En la figura 1 se presenta algunos de los cambios más significativos.

Estos diagramas UVE también han facilitado el proceso de comunicación con el director y miembros del comité de seguimiento tutoral y son han sido un recurso útil para mostrar de manera sintética las transformaciones en la mirada de la estudiante de doctorado.

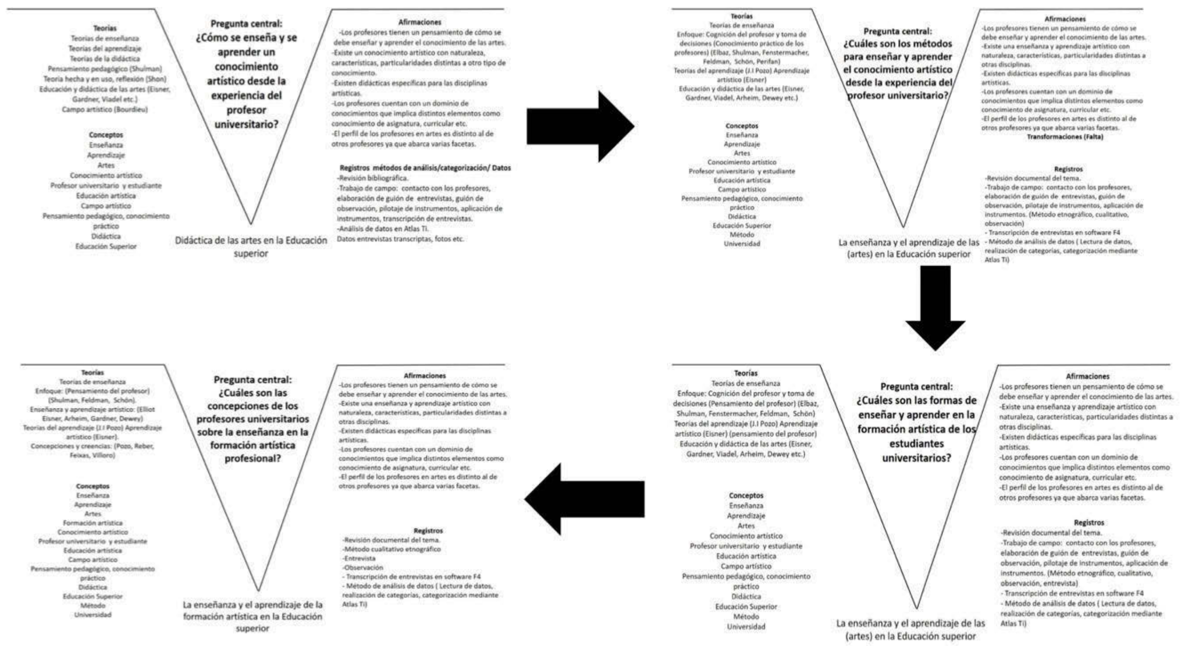

Figura 1. Se muestran algunas versiones de los Diagramas UVE que se realizaron en el proceso de la investigación, esta técnica facilitó la reformulación y definición de problema, preguntas de investigación, así como elementos teóricos y metodológicos.

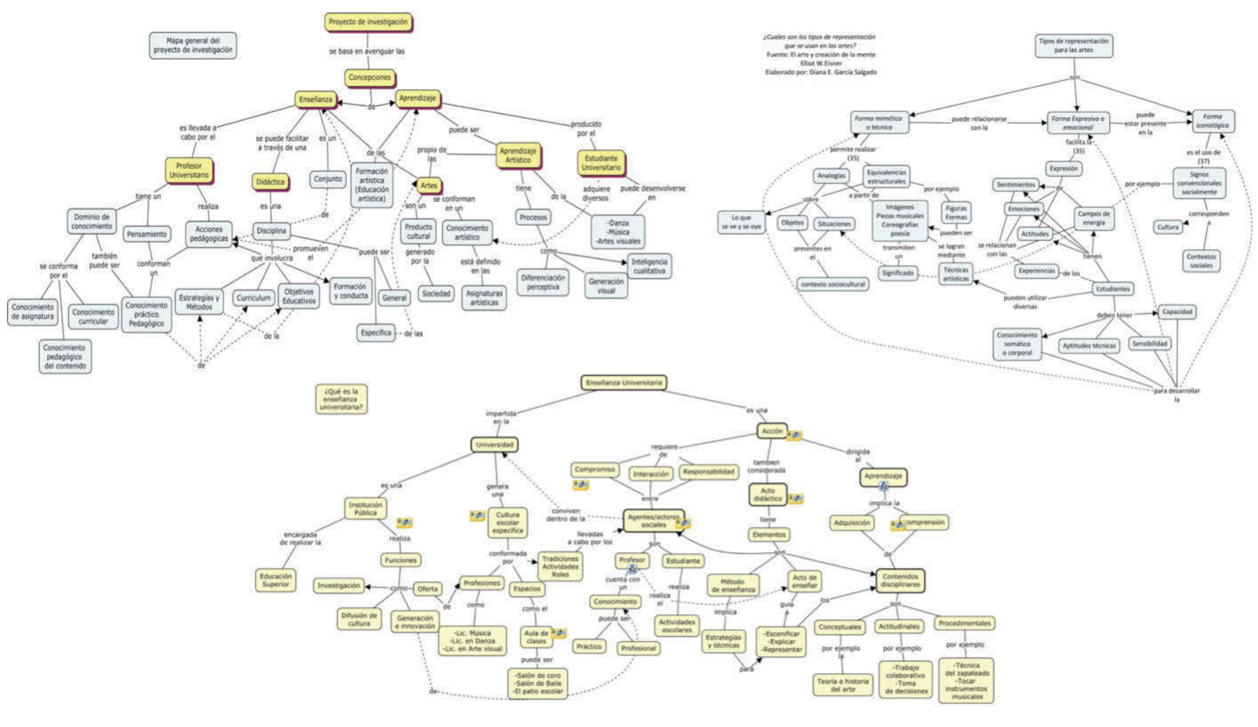

Figura 2. Se muestran mapas conceptuales elaborados para comprender temas generales y conceptos referentes al marco teórico y metodológico.

2.1 Participantes y procedimiento

La revisión de la literatura científica sobre teorías, metodología y estudios relacionados, permitieron la construcción de una metodología para conocer las concepciones de los profesores universitarios sobre la enseñanza y el aprendizaje en la formación artística profesional. De acuerdo a Wittrock (1989), el pensamiento del profesor debe partir de indagar las concepciones y creencias de profesores sobre lo que para ellos es enseñar y aprender. Para ello optamos por utilizar como método la etnografía educativa, que permite la búsqueda de los significados en las situaciones cotidianas que se presentan en las instituciones educativas (Piña Osorio, 1997). La etnografía facilitó el estudio de una unidad social específica y construir un esquema teórico que recoge y responde lo más fielmente posible a las percepciones, acciones y normas de juicio de esa unidad social. (Rodríguez, 1999). Desde la postura antropológica, la etnografía educativa permite "vernos en el otro", "conocer lo desconocido y documentar lo no documentado" (Rockwell & Ezpeleta, 1987). Las técnicas que utilizamos para efectuar etnografía educativa fueron entrevistas semi estructuradas, observación participante y toma de fotografías al escenario educativo observado.

El guión de entrevista se realizó a partir de dimensiones que fueron: biográfica, conocimiento de planes y programas de estudio, enseñanza y aprendizaje, identidad artística y docente. Las entrevistas tuvieron una duración promedio de 60 minutos. Se buscó que los profesores entrevistados llevaran a cabo su labor docente en algún programa de formación artística universitaria, que incluyó los programas de danza, música y teatro. Se entrevistó a 10 participantes y cada entrevista fue grabada y transcrita. Cada transcripción fue leída y analizada mediante ATLAS. Ti. donde se creó una unidad hermenéutica que posibilitó una lectura minuciosa de los documentos y el desarrollo de la categorización mediante la elaboración de citas, códigos, memos, familias y redes entre datos analizados.

Además de las entrevistas se realizó observación participante en cuatro clases donde las asignaturas se relacionaron con la música, la danza y la escenografía. La observación incluyó la documentación visual mediante la fotografía de los materiales utilizados por los estudiantes en clases, los espacios de las actividades como fueron: los salones de música, danza, teatro. La observación y documentación fotográfica de actividades, entre ellas: los estudiantes ejecutando alguna pieza artística, trabajos y tareas elaborados en las clases. Las fotografías fueron de gran ayuda en la documentación visual, estas fueron agregadas en los distintos mapas conceptuales.

3 Mapas Conceptuales y Análisis Cualitativo de Datos

Poco se ha documentado sobre el proceso de análisis de datos a partir del mapa conceptual. Darder, Pérez y Salinas (2014) realizaron un trabajo de investigación en torno a la documentación producida en los congresos internacionales sobre mapas conceptuales, específicamente de los años 2010 y 2012, en sus resultados presentan que sólo en 19 trabajos se aborda el uso del mapa conceptual como herramienta metodológica en la investigación. Ellos presentan que este uso se puede tipificar de esta manera: 1) Método para la reducción de datos, 2) Método para la recogida de información, 3) Método para la guía en la observación. En ese estudio se muestra de forma general estas funciones del mapa conceptual.

Otro trabajo importante es el de Cuenca y Montero (2014) donde se describe y sistematiza de forma más explícita el procedimiento de mapeo conceptual para el análisis cualitativo de datos, el cual se tomó en cuenta para el análisis de datos en este trabajo. De acuerdo con las autoras, el procedimiento genérico de construcción de mapas conceptuales y el análisis de datos cualitativos se desarrolla a partir de etapas: a) Codificación, b) Identificación de relaciones, c) Planteamiento de preguntas, d) Mapeo conceptual de las relaciones encontradas, e) Revisión y comparación.

a) Codificación: Previo al análisis de los datos, consideramos que la escucha de los audios de las entrevistas y sus transcripciones nos permitió comenzar a identificar datos que nos causaron interés y que condujo a la lectura y descubrimiento de conceptos necesarios para un análisis más profundo. El proceso de escucha y transcripción es una etapa previa que prepara al análisis de datos, ya que marca una directriz o postura al investigador para el análisis de los datos.

Las transcripciones fueron reunidas en ATLAS. Ti. para constituir una unidad hermenéutica junto a otros documentos como notas y registros fotográficos. Se dio inicio al proceso de reducción de datos a través de un primer ciclo de codificación (Rodríguez, 1999) y para luego dar paso al desarrollo de categorías, éstas pueden referirse a situaciones, contextos, personas, acontecimientos, conductas, sentimientos y procesos. La codificación es una operación concreta por la que se asigna a cada unidad un indicativo (código) que permite seleccionar cierta información perteneciente a una categoría. (Flick, 2004). La categorización y codificación implicaron la lectura de los documentos, segmentación y depuración de la información. El proceso se acompañó con la elaboración de citas, memos, códigos, familias y redes de códigos. Estos elementos apoyaron a la construcción de conocimientos por parte del investigador, se logró la reducción de datos, un libro de códigos, así como la identificación de hallazgos y la constante restructuración o recodificación de nuevos códigos que iban surgiendo y los existentes (Cuenca Almazan & Montero Hernández, 2014).

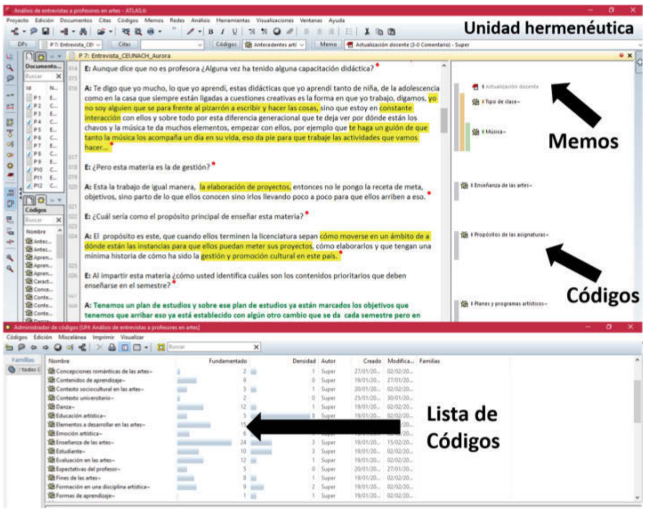

Figura 3. Se muestra ejemplo de una unidad hermenéutica realizada en el software ATLAS. Ti. con algunos elementos que permitieron hacer la reducción de datos de las transcripciones de entrevistas. La elaboración de códigos, memos, citas, segmentación y recodificación de la información fueron actividades y procesos elementales en esta etapa de análisis.

b) Identificación de relaciones: En esta etapa de análisis se hizo una revisión de datos, códigos, categorías y memos obtenidos, esto guió a una serie de relaciones entre la información categorizada y codificada, utilizando las herramientas para elaboración de redes en ATLAS. Ti. se establecieron relaciones entre los códigos obtenidos. Las relaciones se establecen mediante opciones de asociación que ya están programadas en ese software, condición que limita a crear las propias relaciones entre códigos. En las redes los códigos y sus relaciones con otros códigos no expresan la jerarquía de la misma manera que lo hace el mapa conceptual. Aunque en determinados momentos del análisis es posible que los códigos pasen o conformen *conceptos*, no todos los conceptos pueden ser representados por un código. Por lo que las redes, aunque permiten dar inicio a la construcción de categorías, no pueden integrar otros conceptos que implican un nivel interpretativo de los datos. Por ello el mapeo conceptual y CmapTools permiten un nivel analítico distinto. Véase las figuras 4A y 4B.

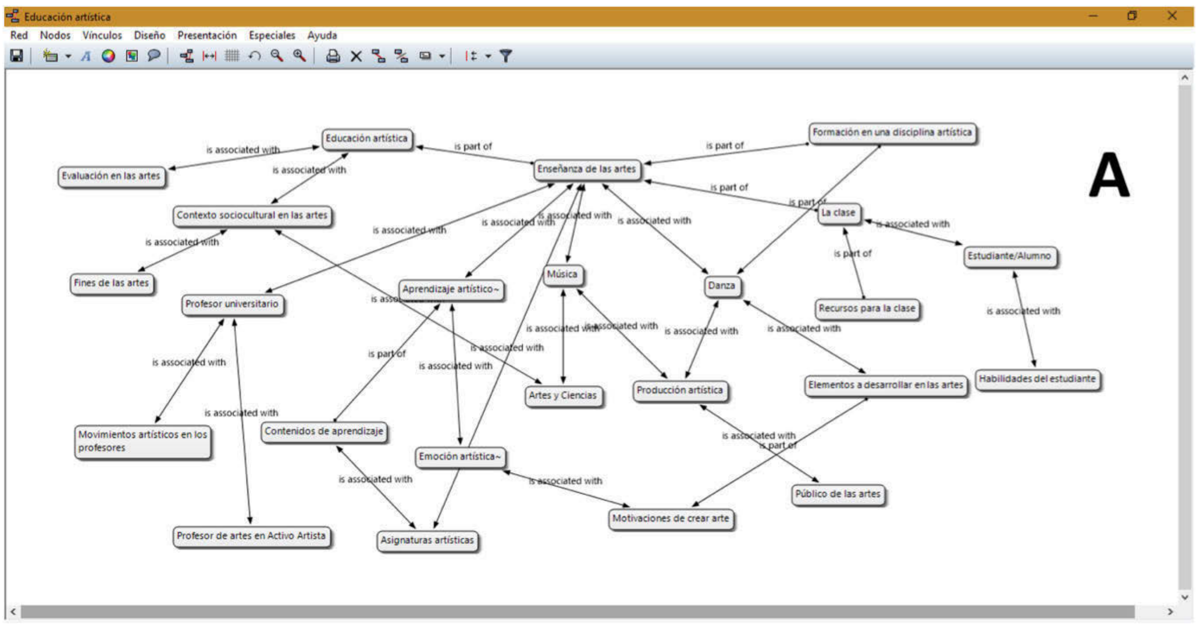

Figura 4. A Red de códigos en Atlas. Ti.

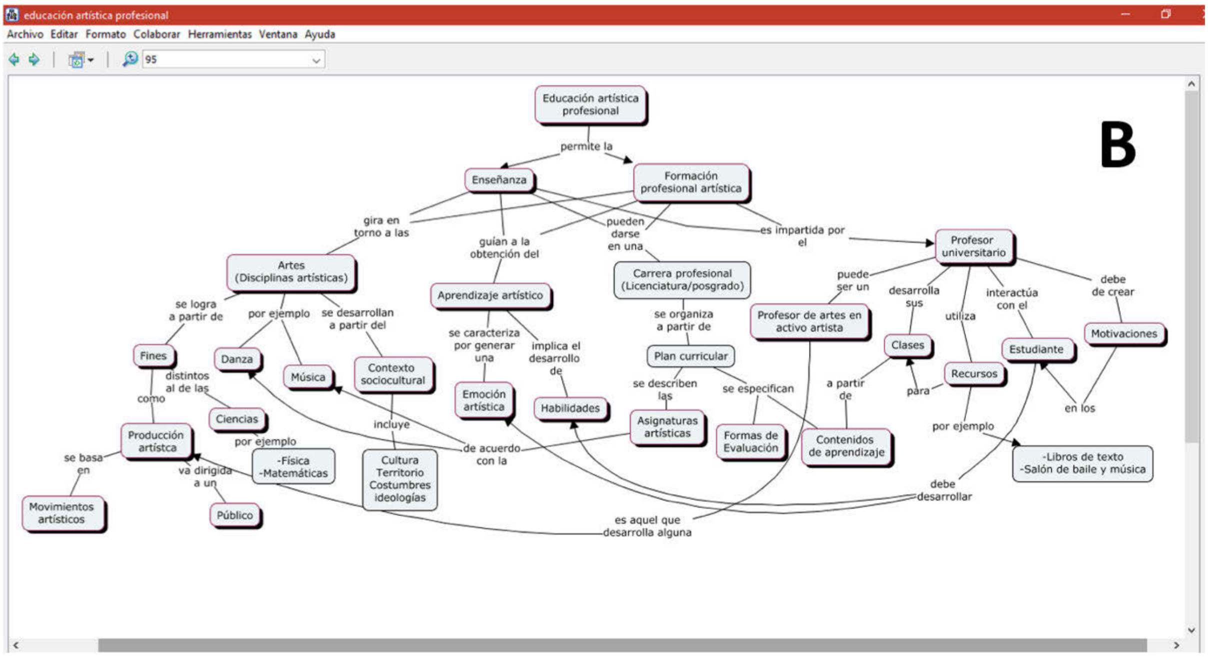

Figura 4B. En la imagen A se muestra una red realizada en ATLAS Ti. que presenta la relación entre ciertos códigos que resultaron en el análisis, la red en ese programa se limitó a los conectores predeterminados que ofrece. En la imagen B se observa un mapa conceptual básico donde se retomaron los mismos códigos con una conexión distinta ya que hubo apertura y libertad de agregar otro tipo de conectores en CmapTools, además se distingue una jerarquía conceptual y se agregaron nuevos conceptos.

c) Planteamiento de preguntas: Tanto en el proceso de codificación y relación entre códigos se produjo una primera forma de entender e interpretar los datos, esta parte del análisis dio pauta al surgimiento de preguntas en torno a lo que se iba encontrando. Por ejemplo, al hacer la codificación de datos resultaron códigos interesantes como aprendizaje artístico, enseñanza de las artes, las clases de artes, retos del profesor universitario, aprendizaje del docente, profesor de artes en activo artista, formación en una disciplina artística, entre otros. De estos códigos surgieron varias preguntas: ¿Qué es el aprendizaje artístico? ¿Qué características hacen que el aprendizaje se denomine cómo artístico?, ¿Cómo es definida la enseñanza de las artes? ¿Cómo se desarrollan las clases de una disciplina artística?, ¿Qué elementos incluye la formación en una disciplina artística? , ¿Cuáles son los retos a los que se enfrenta constantemente el profesor universitario? Estas y otras preguntas se plantearon y sirvieron como preguntas de enfoque para dar respuesta a partir del mapeo conceptual.

d) Mapeo de conceptos: A partir de las preguntas se elaboraron varios mapas conceptuales. Para este proceso se tomó en cuenta los códigos más importantes y distintos conceptos. Cuenca y Montero (2014) refieren que los códigos son derivados de los datos empíricos, generalmente de códigos descriptivos y los conceptos derivan de otros conceptos o de una mayor abstracción. Los conceptos mapeados surgieron del sistema de códigos y los mapas conceptuales respondieron a una pregunta de enfoque. Con el mapeo se representó los códigos y conceptos a partir de una jerarquía, se construyó información de una nueva forma y surgieron otro tipo de relaciones conceptuales entre conceptos y temas. Aparecieron nuevos conceptos a mapear que no se tenían contemplados en un principio y se realizaron varias modificaciones a los mapas ya que, al dar lectura de estos, encontrábamos errores de conceptualización y de jerarquía. La función de notas en CmapTools fue de gran ayuda en este proceso, las notas fueron de acuerdo a puntos relacionados a la estructura del mapa conceptual (errores en estructura, jerarquía, preguntas de enfoque, etc.) y anotaciones sobre los contenidos de los mapas (dudas de los datos, resurgimiento de nuevas preguntas, aclaración de algunos conceptos, relación con los conceptos teóricos, datos de años y fechas etc.). A continuación, se presentan un ejemplo de mapeo conceptual.

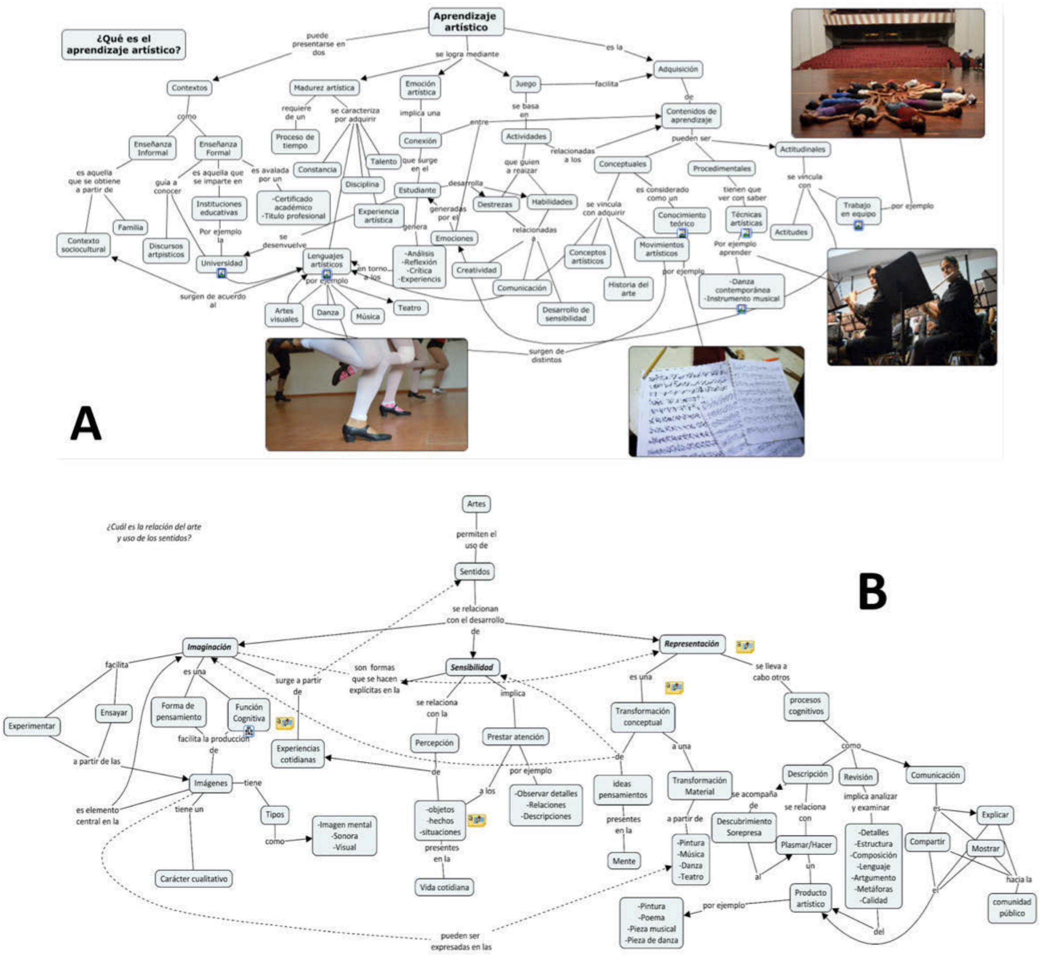

Figura 5. En A y B se presentan ejemplos de mapas conceptuales elaborados a partir de códigos y conceptos que surgieron de un análisis previo. El mapa facilitó la conexión entre distintos conceptos para dar una conceptualización y definición de esos conceptos, en el mapa A se integran fotografías que documentan visualmente el proceso.

e) Revisión y comparación: En esta etapa se dio revisión final a los mapas conceptuales cuidando que la información fuera correcta, tanto en el contenido como las preguntas de enfoque, palabras enlace, jerarquía y el diseño visual de los mapas. En algunas ocasiones los mapas pueden ser organizados mediante un modelo de conocimiento, (García Salgado, Aguilar Tamayo, Espinosa Montero, & Manzano Caudillo, 2014) en el caso de esta investigación nos queda de tarea crear un modelo de conocimiento que integre diversos mapas, no obstante, faltan otras etapas de trabajo de campo, codificación de nuevos datos y una segunda etapa de mapeo conceptual que en otro momento permitirán la elaboración del modelo.

En cuanto al tema de la comparación, algunos mapas conceptuales en torno a códigos derivados del análisis de datos fueron comparados con mapas conceptuales elaborados a partir de las teorías científicas en torno al tema. Por ejemplo, el concepto de aprendizaje artístico fue mapeado en un principio a partir de la bibliografía revisada, es decir, a partir de lo que en los textos científicos se define como aprendizaje artístico. En la etapa de codificación, aparece el aprendizaje artístico como un código y en el desarrollo de las entrevistas, los profesores describen definiciones, características y formas del aprendizaje artístico. Estos elementos derivan de las experiencias propias de los docentes y que, en el análisis, dichos datos se convirtieron en códigos y conceptos a mapear. De manera que se compararon ambos mapas, el mapa sobre aprendizaje artístico realizado según las teorías científicas y el mapa sobre aprendizaje artístico a partir de lo obtenido en las entrevistas, de las vivencias reales y teorías pedagógicas de los profesores. En algunos casos como este, el mapa conceptual facilitó ver la diferencia de aquello que proviene de un conocimiento científico con los conceptos cotidianos derivados de las personas.

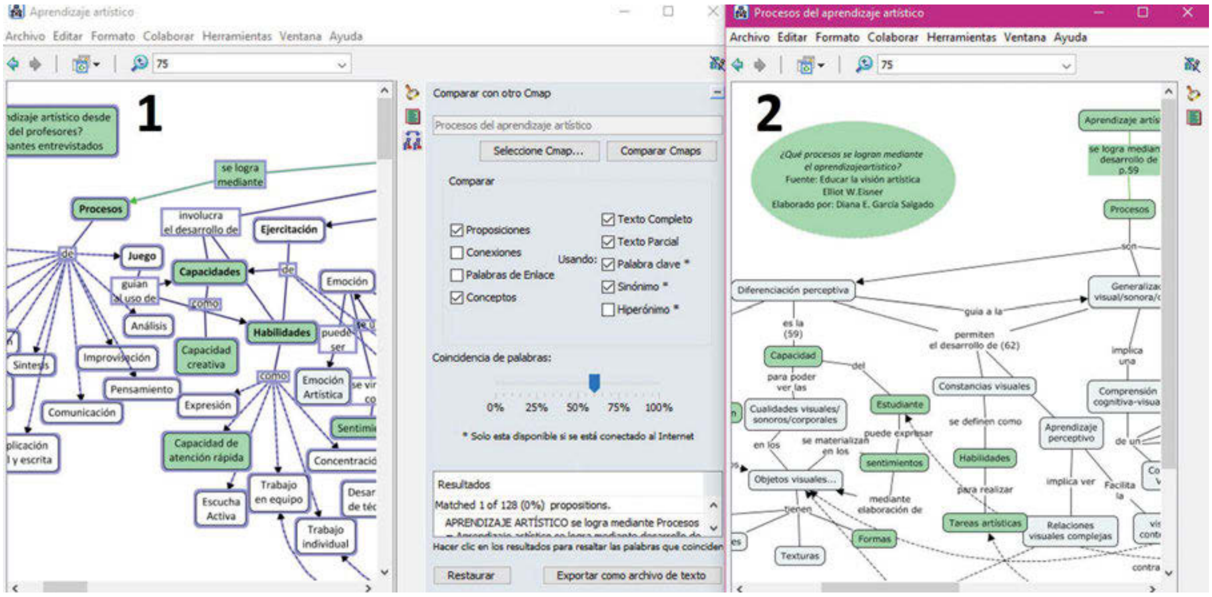

Figura 6. 1.Se observa fragmento de mapa conceptual sobre el concepto de aprendizaje artístico obtenido del análisis previo de ATLAS. Ti y que en CmapTools se refuerza el análisis mapeando una definición del concepto, así como otros elementos. En el mapa 2 se muestran los procesos del aprendizaje artístico de acuerdo al mapeo de un capítulo de libro. En este ejemplo se mapearon y compararon tanto la versión del aprendizaje artístico desde un conocimiento teórico sistematizado y la versión del concepto desde las concepciones de los profesores universitarios.

4 Conclusiones

Los mapas conceptuales en la investigación educativa constituyen una buena herramienta en las distintas etapas que esta conlleva. Las funciones que cumple son distintas, y el mayor uso se extiende al análisis de reducción de datos que incluye la categorización y codificación de datos. (Cuenca Almazan & Montero Hernández, 2014) (Darder, Peréz, & Salinas, 2014). En el caso de este estudio se consideró relevante también, mostrar que previo al análisis cualitativo de los datos, los mapas conceptuales junto con los diagramas UVE facilitaron la comprensión del marco teórico y en la construcción de la problemática. El planteamiento de preguntas de enfoque en los mapas contribuyó a la resolución de dudas teóricas, metodológicas e incluso personales sobre el diseño de la investigación. Es interesante que el mapeo conceptual pueda estar presente en diferentes etapas de una investigación, lo que habla de las múltiples funciones que esta técnica desempeña.

En relación al mapa como una técnica para análisis cualitativo de datos facilitó la reducción de datos, la representación de códigos y conceptos extraídos de transcripciones de entrevistas. Una de las ventajas del mapa conceptual en la investigación es que permite la representación de conocimiento teórico y científico, conocimientos propios del investigador y el conocimiento de "otros", por ejemplo, el mapeo de concepciones de los entrevistados. Claro que esa conceptualización está ligada a la subjetividad del investigador, sería interesante que bajo los códigos y conceptos resultantes de una entrevista se realizara un mapa conceptual junto con el entrevistado, una construcción in vivo y conjunta con el participante. De forma que se obtendría la versión conjunta del entrevistado y el investigador.

En cuanto a las etapas del procedimiento cualitativo de datos, los mapas conceptuales posibilitaron un análisis y desglose detallado de los códigos y conceptos, la re-elaboración de los mapas permitió la constante transformación de los datos y por lo tanto otras formas de entender y analizar la información. La creación y reformulación de las preguntas de enfoque, las relaciones que surgieron entre conceptos y entre mapas conceptuales enriquecieron el análisis de la información. Habrá que explicitar y sistematizar más las experiencias en cuanto al mapeo de conceptos en el proceso de investigación, reconocer su importancia y relevancia en este proceso. El mapa conceptual es una técnica que ayuda al aprendizaje significativo propio de la investigación educativa.

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ONTOMAP: FROM CONCEPT MAPS TO SHALLOW OWL ONTOLOGIES

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Abstract. Knowledge representation is one of the areas that Education is concerned with. Recently, ontologies have gained great importance as a way of representing knowledge. Thus, several researchers have investigated the creation of ontologies from concept maps. This paper explains the process of mapping a concept map into an OWL ontology and shows the conceptual architecture of a system designed to accomplish this task. Functions aspects are also discussed and necessary adaptations to conventional concept maps editors in order to make them able to support such mapping. In addition, a comparative analysis of existing web tools is provided, highlighting their strengths and weaknesses. Besides, we present a prototype as a proof of concept.
Keywords: ontology, concept map, OWL

1 Introduction

In the context of Education, there are several ways of knowledge representation, such as text, drawings, concept maps, among others. Recent studies have tried to bring the benefits of ontologies into the field of Education, but its excessive formalism has hindered researchers seek for more informal ways. Thus, many studies are being conducted on the use of concept maps for building ontologies. On one hand, concept maps are informal, simple to construct and easy to understand. On the other hand, ontologies are formal and difficult to create, hence requiring the presence of an expert to create them.

Concept maps are graphical tools for organizing, representation and knowledge construction. They are formed by concepts, generally represented by circles or boxes of some type, an arrow to link two or more concepts and a label for defining the nature of the relationship (Novak & Cañas, 2008). An Ontology is an explicit and formal specification of a shared conceptualization (Studer, Benjamins & Fensel, 1998). In (Guarino, 1998), can be found more information about this definition.

In Information Technology, there are several modeling languages able to represent knowledge about a particular domain, each with its own objectives and levels of complexity in the creation of their models. Some of these languages can be more expressive, e.g. UML (OMG, 2003), OntoUML (Guizzardi, 2005) and OWL (Dean et al., 2003), while others are less expressive, e.g. ER (Chen, 1976) and concept maps (Novak & Gowin, 1984). It is worth to note, although more expressive languages can represent knowledge more clearly and with good fidelity to the domain, their use is not always better suited when compared to other less expressive languages, as show in (Siau, Erickson & Lee, 2005). Along the expressiveness comes complexity, which means that the more expressive, more complex is the development of models, in addition to increasing the computational complexity (Brachman & Levesque, 2004). This fact complicates the process of building models by domain experts, especially in Education, where experts possibly do not have expertise to use those complex modeling languages, such as OntoUML (Guizzardi, 2005) or OWL (Dean et al., 2003).

Figures 1, 2 and 3 represent the same domain described in different modeling languages, showing their different purposes and levels of complexity in the construction of models. By analyzing in particular Figures 1 and 2, which show typically ontology languages, it is evident the difficulty that a domain expert would have in knowledge representation. In contrast, Figure 3, showing a concept map, makes clear the simplicity and informality of the language.

Therefore, this work proposes, by means of concept maps, provide to non-experts in ontologies the ability to represent knowledge of any domain, simply and without the need for a computer specialist. In other words, this work aims to transform the informal knowledge described by concept maps in formal knowledge of shallow ontologies described in OWL language, which is the standard adopted by the Semantic Web.

Why Ontologies can be important in Education? What are the possibilities of their uses? As far as knowledge representation is concerned, concept maps and ontologies have the same purpose. Its main difference lies in the fact that one is formal and the other not. In computer terms, ontological models carry higher semantics compared to concept maps. Because of this, their representative capacity increases exponentially.

Several activities can be supported by ontologies in Education, such as: 1) the initial identification of the domain of knowledge, for example, for the automatic generation of concept maps, is very difficult. A software agent, driven by an ontology, can identify with a certain precision and quick way the source text; 2) ontologies can guide intelligent agents in building cognitive profiles of apprentices, providing them customized mediations; 3) questions in natural language on a given domain of knowledge can also be automatically answered by an agent oriented by domain ontologies; 4) texts can be grammatically corrected, among many other applications.

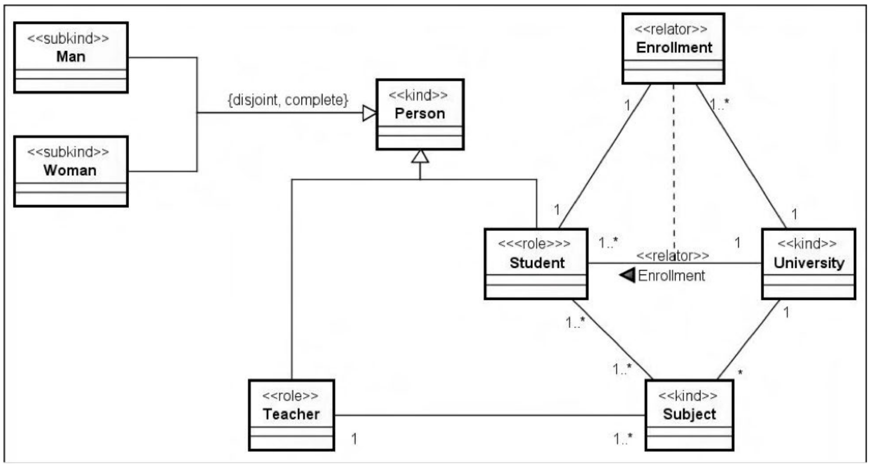

Figure 1. Example of a domain represented in OntoUML.

```
<owl:Class rdf:about="http://example.com/test#Man"/>
<owl:Class rdf:about="http://example.com/test#Teacher">
  <rdfs:subClassOf>
    <owl:Class rdf:about="http://example.com/test#Person"/>
  </rdfs:subClassOf>
</owl:Class>
<owl:Class rdf:about="http://example.com/test#Subject"/>
<owl:Class rdf:about="http://example.com/test#Student">
  <rdfs:subClassOf rdf:resource="http://example.com/test#Person"/>
</owl:Class>
<owl:Class rdf:about="http://example.com/test#Woman"/>
<owl:Class rdf:about="http://example.com/test#University"/>
<owl:ObjectProperty rdf:about="can be">
  <rdfs:range rdf:resource="http://example.com/test#Woman"/>
  <rdfs:label xml:lang="en">can be</rdfs:label>
  <rdfs:range rdf:resource="http://example.com/test#Man"/>
  <rdfs:domain rdf:resource="http://example.com/test#Person"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:about="has">
  <rdfs:label xml:lang="en">has</rdfs:label>
  <rdfs:range rdf:resource="http://example.com/test#Subject"/>
  <rdfs:domain rdf:resource="http://example.com/test#University"/>
</owl:ObjectProperty>
```

Figure 2. Source code snippet of a domain represented in OWL generated by OntoMap service.

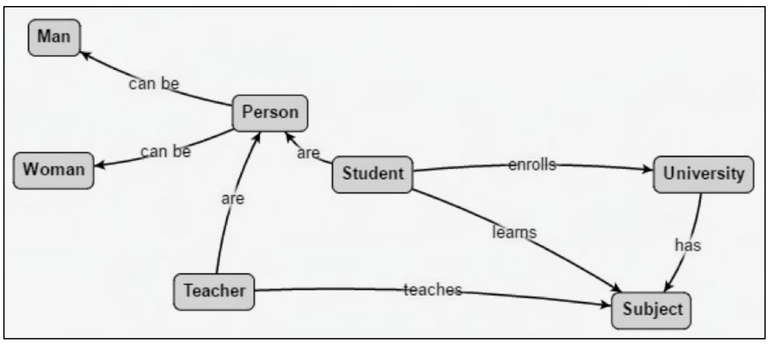

Figure 3. Example of a domain represented by a concept map.

We present a proposal of a conceptual architecture of a system we are calling OntoMap. The OntoMap is an idealized tool with the purpose of transforming concept maps in OWL ontologies. The tool is the result of the interaction of two basic parts: an adapted concept maps editor, and a service that contains the logic for mapping concept maps into OWL ontologies. The editor can be accessed through our Portal (Cury & Menezes, 2012). The service is hosted on a web-oriented platform services, called CMPaaS (Cury, Perin & Santos Jr, 2014). This platform is a major project which houses several services on concept maps and will be presented in Section 2 of this paper.

For the idealization of OntoMap tool, a critical analysis of some of the main tools available for download was held. The OntoMap differs from them because:

- It is part of a larger project that uses services for communication between client and server;
- Its implementation is based on SOA architecture, where its business logic was developed as a service;
- It incorporates the best features of the main available tools;
- It intends to enrich the shallow ontology created promoting integration with DBpedia.

This paper is structured as follows: Section 2 presents the context to which our tool belongs. Section 3 presents a literature review of the state of the art and technology. Section 4 discuss about the mapping process adopted. Section 5 describes the proposed architecture explaining each component of it. Finally, Section 6 presents a discussion and further work.

2 On the Context

We have been exploring, for about 15 years, concept maps applied to the learning process. During this time we have supervised numerous undergraduate and masters as well as PhD projects on the subject. Each of these jobs generated prototypical tools that have evolved over time, some of them already in production. However, as isolated tools they are inefficient. Therefore, we decided to integrate them. This section will be a brief discussion on concept maps in learning and why we need ontologies from a map, and also something about our web platform.

2.1 Maps in Learning

Concept maps are graphical representations of relationships between concepts. They have been used in many different fields of knowledge. In particular, they have attracted the interest of educators worldwide. Novak (Novak & Cañas, 2008), their creator, defines concept map as a tool for organizing and representing knowledge. The concept map, based on the meaningful learning theory of Ausubel, defined in (Ausubel et al., 1968), is a graphical representation of a set of concepts constructed in such a way that the relationships between them are evident. Concepts appear in boxes while the relations between concepts are specified by means of phrases that connect the concepts. Concepts are defined by nouns while linking phrases must have a verb or a verbal composition. Two or more concepts connected by linking phrases creating a semantic unit, we call a proposition. Each proposition defines a truth, a fact, detachable and understandable by itself. The propositions are a particular feature of the conceptual maps as compared to other similar structures such as mental maps or flowcharts. According to Novak, a concept map is a hierarchical tree structure, for the concepts, where the more general, or inclusive concept, appear at the top and the more specific ones in the lower parts of the tree.

However, there are different pedagogical approaches where the use of concept maps can help students in the processes of signification of new contents or even on the resignification of those already learned concepts. This happens mainly because the maps allow students to locate and establish relations of composition, similarity, differentiation, or equivalence between what they are learning and the concepts already present in their cognitive structure. Therefore, various researches are being conducted and new tools developed to enable the use of maps for different pedagogical practices.

According to Jean Piaget's Genetic Epistemology (Piaget, 1988), the mechanisms involved in the process of conceptualization imply an assimilation (the incorporation of an external element to a scheme of action or to a concept of the subject), starting from the active coordination of the actions of the subject and also the coordination of the observables of the objects of knowledge. Thus, the fact that an assimilation occurring in accordance with the possible accommodation (which is the need of the assimilation of taking into account the particularities of the elements to assimilating) requires the transformation of the systems of signification of the subject (which implies an update of the so-called "prior knowledge") so that these can integrate (and not just “to anchor”) new knowledge.

According to Dutra *et al* (2004) we can follow the representation of the system of meanings of a student on the dynamics of building a concept map. In this system we also recognize relating subsystems, supporting each other, for the construction of these meanings.

It is essential to highlight the central role of linking phrases in a concept map. When we compare concept map with Piaget´s knowledge structure, we can conceive the linking phrases as the structuring functions since they are responsible for the laws of composition of the system represented by the map. Jonassen (1996) stresses the effort to choose a phrase that represents a relationship between two concepts, both due to the large number of possibilities as well as the need of placing such a relationship in the context in which the pair of concepts is presented.

As learning processes are the result of student-student and student-teacher partnerships, we understand that concept maps can also serve as an important guide for students, alerting them about the constant possibility of enhanced versions with concepts and relationships qualitatively more significant.

2.2 Ontologies from Concept Maps: Why?

Ontologies and concept maps are very similar languages, especially under a point of view of their structures. Because of their graphical topologies, computers can easily process both. However, concept maps do not require the rigid formalism of the ontologies. Besides, their propositional structures are very similar to the structure used to represent the properties in description logic. Authors in (Zouaq, Nkambou & Frasson, 2007), (Starr, 2009), (Gomez-Gauchia & Diaz-Agudo, 2004), among others, suggested a procedure to support the transformation of concept maps in a knowledge base represented in description logic.

The ontologies have been represented primarily in description logic. They have played an important role in countless activities, especially in knowledge management with respect to the construction of intuitive human-machine interfaces, intelligent information retrieval and semantic web, among other activities. Ontologies have also been used to capture knowledge about some domain of knowledge.

We are interested in shallow ontologies especially in support of learning assessment. Using an architecture based on agents, ontologies can also guide the construction of virtual environments to support learning and cognitive modeling of students, considering their individual productions and those resulting from their collaborations. They are also good in intelligent tutoring systems, when a tutor agent can infer more appropriate mediation paths, on a straight dependence on the learner's profile.

An ontology may also play an important role on the automatic generation of concept maps from text. Herein, to find the domain of the knowledge is a very difficult task. An agent guided by a domain ontology can make it easier. Ontologies can also be useful in supporting the construction of grammatically correct text.

2.3 On our Platform

When dealing with the development of computational solutions, the subject in vogue in recent years is undoubtedly cloud computing. This is a computing model in which processing, storage and computing solutions (software) are offered by a service provider accessed remotely via the Internet. This technology allows applications to perform to retrieve information from anywhere, from any platform at any time, using only web instead of locally installed applications.

The main advantage offered by cloud computing is the ability of its services to be easily extended and integrated into the various applications, thus increasing productivity when creating new applications. Because of this, large companies in the information technology industry (e.g. Facebook, Apple, Google, Twitter, etc.) provide their API's (Application Programming Interfaces) to access their services using this computing model. Just to cite one example, a cloud application is widely used Google Maps.

Today, there are numerous applications that extend their functionality by offering complementary services such as geolocation applications that control the route, pace and/or calories consumed by an athlete in a physical activity. For this project, we seek to exploit this capacity expansion and productivity. We are creating the basic editing services, management and manipulation of concept maps that will be available to anyone in the world through our service platform.

One of the key features of the software architecture to be used in this project, known as SOA (Service Oriented Architecture), is its ability to promote integration. This means that new services that extend the functionality of the services offered by our platform can be developed and made available by anyone and anywhere in the world.

To date, this platform aims to offers the following services:

- Automatic generation of maps from unstructured text (Aguiar, Cury & Gava, 2015);
- Merge maps (Vassoler, Perin & Cury, 2014);

- Comparison of maps;
- Map editor;
- Correction maps;
- Information retrieval from questions in natural language (Perin, Cury & Menezes, 2014).

Section 4 presents more details about the system architecture of our project as a whole, highlighting its two main layers.

3 From Concept Maps to Ontologies: A Literature Review

The first step in construction of this work was to read articles and testing the tools available for download on the web, in order to discover their basic features, their strengths and weaknesses. We have found three systems and, due to a lack of space, only a summary of their most important features is shown below in Table 1. Details are better shown in (Pinotte, Cury & Zouaq, 2015).

Tool	Advantages	Disadvantages
COE (Hayes et al., 2005)	• Mapping done through predefined stereotypes; • Stable environment and available for download; • Editor highlights the difference between classes, individuals and attributes; • Construction of simple map where the user is not forced to choose stereotypes of relations.	• Editor does not automatically change the layout of different elements, such as classes and individuals; • The user does not have a menu where you can select whether to show the different elements of OWL, such as classes, individuals and attributes, which makes polluted editor view (with lots of information); • The user does not know what each stereotype represents in the OWL language.
MAP2OWL (Garcia et al.,2008)	• It works with OWL natively, i.e., it does not perform algorithm transformation between conceptual and OWL maps; • The editor highlights the difference between classes, individuals and attributes; • The editor allows the user to select whether to display different elements of OWL, such as classes, individuals and attributes;	• Being plugin Protégé, the tool is limited to the use of Protégé; • Works only in version 3.3 of Protégé; • For a good representation of knowledge, the user needs to know the meaning of words such as functional, symmetric, transitive, among others;
(unnamed) (Simón, Ceccaroni & Rosete, 2007)	• Mapping is done through natural language processing; • The user creates the concept map without having any knowledge in OWL; • The concept maps editor do not need any kind of adaptation to perform the mapping.	• It works only in Spanish; • Algorithm depends on WordNet in Spanish; • By mapping occur through natural language processing, the rules of inference are limited.

Table 1: The systems main features

We conclude that the tools described in this section serve as a basis to construct the conceptual system architecture of OntoMap (Section 5), which will be explained in more detail in the following sections.

We point out that we had access only to the editors of the COE and MAP2OWL where testing the same was possible. For our prototype, we seek to maintain the main advantages we find these tools analyzed and eliminated what we consider as weakness or weaknesses. For our map editor, we joined characteristics of these two tools. The following are the features that we decided to keep with our editor:

- A list of predefined stereotypes. These stereotypes are available for the user when creating a new relationship: feature from COE;

- Selection Tabs to display the different elements such as the OWL classes, individuals and attributes, thus, for the user to decide which elements he/she wants to display on the screen: feature from MAP2OWL;
- Visually it differentiates the elements of OWL. These elements are: classes, individuals and attributes. For this, we take as a basis the project VOWL[1]: this feature was found in both COE and MAP2OWL;

With these characteristics, we believe that we were able to maintain the simplicity of the concept maps editor without visually polluting the user's view.

4 About the adopted Mapping Process

In the computing area it is common to adopt stereotypes to represent the necessary formalism of modeling languages or even programming languages. Thus, when a certain stereotype is used in a domain, it is understood that it will always have the same meaning, regardless of context. Based on that, this work adopts the use of stereotypes to build the necessary formalism to ontologies. This decision follows both the need for the creation of ontologies inherent formalism, as well as the critical analysis of the tools related to this work (Section 3). In addition, in order to maintain the simplicity of the concept maps, we decided to create stereotypes in natural language, which would allow any domain expert to use the proposed tool without the help of any Information Technology expert.

Being a work at an early stage, we decided to cover only the main constructors of the OWL language. Table 2 shows the stereotypes in natural language, their corresponding constructor in OWL and propositions to illustrate its use.

Stereotype	Constructor in OWL	Proposition
“are”	<rdf:subClassOf>	Professor “are” a Person
“equivalent to”	<owl:equivalentClass>	Person is “equivalent to” Human Been
“cannot be”	<owl:disjointWith>	Man “cannot be” a Woman
“exact the opposite of”	<owl:complementOf>	Human Being is “exact the opposite of” Extraterrestrial
“is composed of”	<there is no constructor>	Person “is composed of” Head and Body
“is a”	<there is no standard defined by W3C>	João “is a” Student
“same as”	<owl:sameAs>	João is “same as” Jhon
“different from”	<owl:differentFrom>	João is “different from” Maria
“is an attribute of”	<owl:DatatypeProperty>	Height “is an attribute of” Person

Table 2: Description of the stereotypes.

5 OntoMap: The Conceptual System Architecture and Technology

The proposed architecture is the result of the review we did of some tools as shown in the previous section. The architecture, however, differs from analyzed mainly because it is part of a broad platform of services based on SOA (Service Oriented Architecture), in which OntoMap will have its hosted service. Being an open-source platform, OntoMap can be used by the general community, and its services can be extended and improved by proper client applications. In addition, the editor of OntoMap can be accessed via our portal, which is a web system, requiring only an Internet connection.

OntoMap carries other innovations that allow building shallow ontologies that can be shared on the web. We idealize our tool as an information provider, i.e., an ontologies provider. A bank of ontologies will be available through connection to DBpedia[2], thus establishing a connection with the Linking Open Data[3]. Moreover, it is

[1] VOWL (Visual Notation for OWL Ontologies). Available in: < http://vowl.visualdataweb.org/>

[2] DBpedia. Available in: <http://wiki.dbpedia.org/>

[3] LOD (Linking Open Data). Available in: <http://www.w3.org/wiki/SweoIG/TaskForces/CommunityProjects/LinkingOpenData>

possible to make sophisticated queries on Wikipedia and link different sets of Web data with the ones already present on website, so providing interoperability.

As we said, the OntoMap is the union of a web service, hosted on our platform, with an adapted editor of concept maps, accessed through the use of our Portal. Therefore, we can say that the Portal is the user interface layer, and the platform properly is the services layer. Figure 4a shows the architecture in a macro view of two layers, where the arrows indicate the Portal applications accessing services in the service layer. It is noticed that an application in the view layer can access more than one service on the platform, and a service on the platform can serve more than one application on the Portal. The services hosted on our platform will be available for use by the whole community, free. Thus, it is possible that another Portal (client) to consume them and use them any way the users want. Besides, whit this architecture, it is possible to extend our hosted services (Figure 4b).

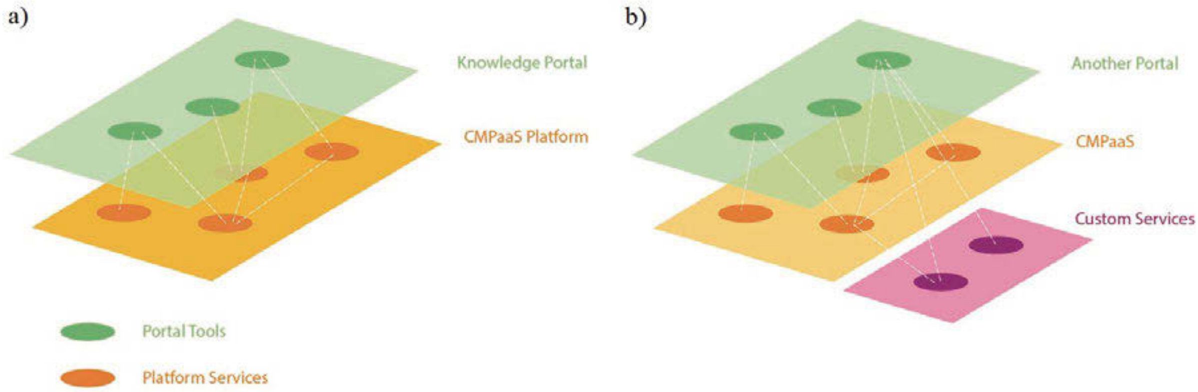

Figure 4. A macro view of the SOA architecture of the project.

The aim of the proposed architecture is therefore to generate shallow ontologies in OWL, straight from concept maps, making unnecessary the presence of experts in knowledge representation, throughout the process. In other words, we intend the resulting tool from that architecture, the OntoMap, to be used by experts of any domain in a simple and friendly way.

Figure 5 shows the conceptual system architecture of OntoMap itself, an updated version presented in (Pinotte, Cury & Zouaq, 2015), highlighting each module thereof. It shows the elements that are arranged in the layer of vision (Extended Editor and Creator module) and the elements of the service layer (Mapper, Coder and Integrator modules) which will be explained in the following steps.

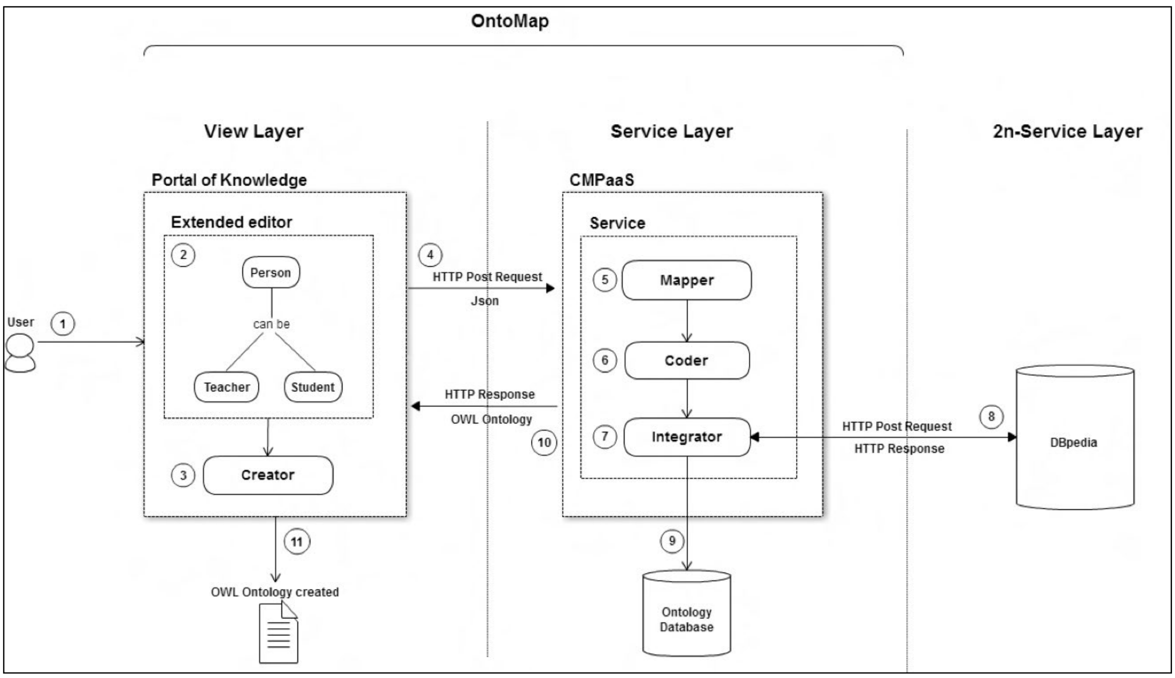

Figure 5. Detailed system architecture.

1. Through the access[4] on our Portal, the user can use the OntoMap tool;
2. When the authentication process is already done, the user can access the ontology editor (Figure 6). The ontology editor provides some additional features for the user compared to a common concept maps editor (further details will be explained later in Section 5). At any time when constructing a map, the user can click at the button labeled “Export Map in OWL Ontology”;
3. After step 2, the Creator module is responsible for the creation of a JSON file corresponding to the map created by the user;
4. After step 3, the Creator module sends the map to the server through a HTTP Post request via Ajax;
5. On the server side, on our service layer, the Mapper module is responsible for receiving the map in JSON format and to interpret it by creating a list of propositions. To perform the whole process, it is important to say the need of compatibility between the file generated by the Creator module and the input file received by the Mapper module;
6. Whit the list of propositions created on the step 5, the Coder module performs the conversion in fact by encoding the map into OWL ontology This module contains an interpreter with the list of pre-registered stereotypes (available on the creation of a new relation on Extended editor) and their constructors of OWL language. Thus, upon receiving the message of the Mapper module, the Coder is responsible for axiomatize the ontology, by converting the concepts, presented on the concept maps, in *Classes*, *Individuals* and *Datatype Properties* (elements of the OWL language) and the relations in *Object Properties*.
7. The Integrator module is responsible for sending a message to the DBpedia’s dataset adding some eventual information requested;
8. DBpedia receives the request and sends back a message with the information requested;
9. After step 8, the Integrator module is responsible for saving the OWL ontology created on our Ontology database, that will eventually be adapted to standard of Linked Data[5] being part of Linking Open Data;
10. After step 9, the Integrator module sends the OWL ontology created back to the client layer;
11. To finish the whole process, the client saves the OWL ontology locally.

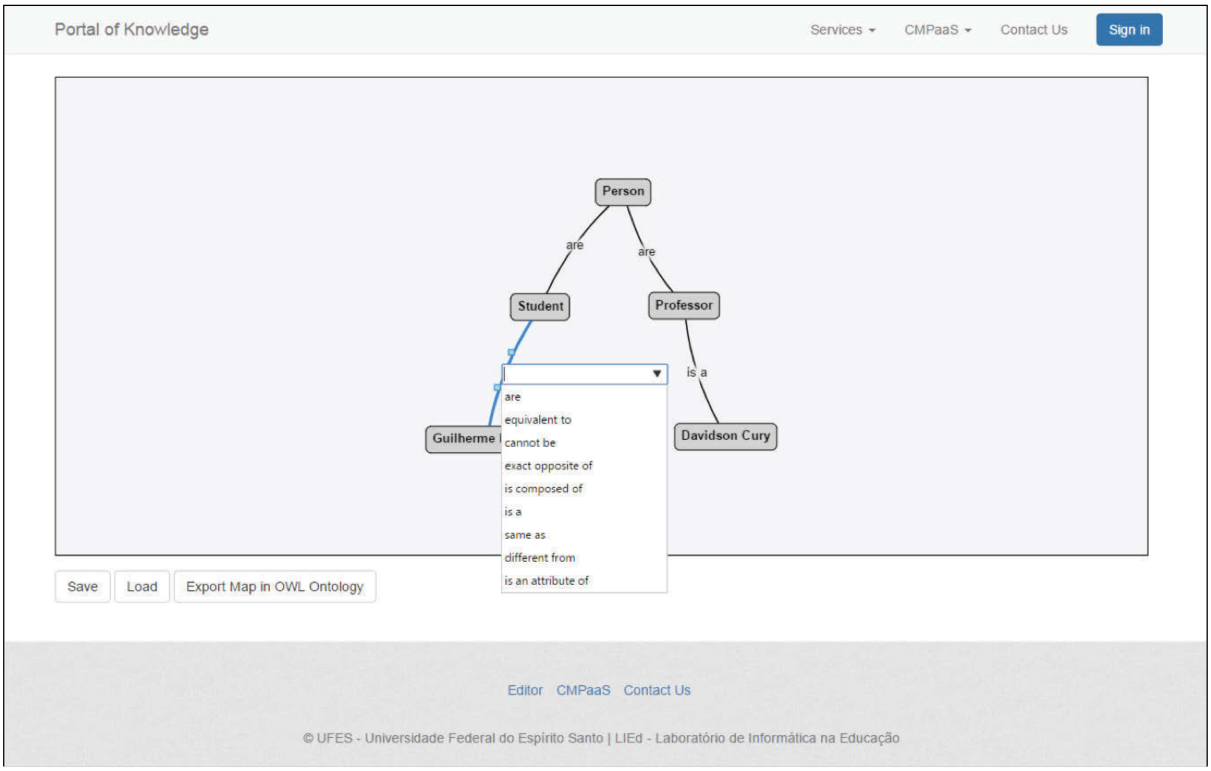

Figure 6. OntoMap’s Editor prototype.

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[4] Available in: http://cmpaas.inf.ufes.br/
[5] Linked Data. Available in: <http://linkeddata.org/>

6 Discussion and Further work

Researches in Education are always looking for new ways to represent knowledge. Concept maps and ontologies are instruments of representation and knowledge building, each with their specific purpose and level of complexity. On one hand, concept maps are informal and easy to use. On the other, ontologies are formal and complex, requiring an expert in Knowledge Engineering to create them. Therefore, this study sought to unite these two worlds by giving the possibility to domain experts to create OWL ontologies (standard adopted by the Semantic Web), and then to share it on the web.

Each of the tools discussed in Section 3 were the basis for the idealization of the OntoMap tool. We are striving to maintain the main advantages of the analyzed tools and eliminate what we see as weaknesses. However, the OntoMap maintains certain differences from the others. Being part of a larger environment, our solution is one of the services of a web platform. To our editor, for example, we decided to keep the stereotypes of COE and the tabs from the MAP2OWL. Thus, we were able to maintain the simplicity of the editor of concept maps without visually pollute the user's view, giving him/her the chance to decide what to display on the screen.

It is important to say that this work is only an early version. In order to use and validate our tools, we have a course teaching how to use concept maps in virtual environments, using our Portal, for teachers of public schools in Brazil, Espírito Santo. This course will start in a few months of this year and it will be important for the dissemination and use of our tools as well as their validation and improvement. Thus, future work converges in improving the ontology editor (visual part) as the existing service, which will consist in seeking for the incorporation of new stereotypes of relationships in order to map other constructors of the OWL language. Moreover, we intend to provide the shallow ontologies created on our platform to the Linking Open Data, by means of a link with the DBpedia. To perform it, we are intending to start the development of the Integrator module and the Ontology Database.

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REGULACIÓN SOCIAL DEL APRENDIZAJE COLABORATIVO CON MAPAS CONCEPTUALES: INFLUENCIA DEL TIPO DE TAREA

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Abstract. En este trabajo se analizan los efectos del tipo de tarea colaborativa (elaboración de mapas conceptuales vs elaboración de resumen expositivo) en el rendimiento y en el nivel de colaboración que alcanzaron estudiantes universitarios mexicanos en el aprendizaje con multimedia de un contenido de ciencias sociales (Psicología de la Comunicación). Asimismo, se describen los procesos de regulación social que se manifiestan en dichas tareas colaborativas. Participaron en el estudio 45 estudiantes (17 mujeres y 28 hombres) agrupados en 15 triadas. Cada triada fue asignada a una de las dos condiciones colaborativas: elaboración de mapas conceptuales (8 grupos) y elaboración de resumen expositivo (7 grupos). Se controló que no existieran diferencias significativas previas entre las condiciones respecto a comprensión lectora, estrategias de regulación de la comprensión lectora y conocimientos previos en el dominio específico. Para valorar el rendimiento en el aprendizaje se tuvo en cuenta tanto la calidad de las proposiciones explicitadas en mapas conceptuales y resúmenes, adaptando el procedimiento propuesto por Haugwitz, Nesbit y Sandmann (2010) como también los resultados obtenidos por los estudiantes en un cuestionario de elección múltiple sobre el dominio de conocimiento. Asimismo, se examinó el nivel de colaboración percibido por cada integrante de los equipos empleando el cuestionario de Colaboración de Chan y Chan (2011). La identificación y caracterización de los procesos de regulación social se realizó mediante un análisis cualitativo de los intercambios registrados durante la actividad colaborativa, considerando el tipo (coregulación y regulación compartida) y la orientación de la regulación (dirigida a la tarea o bien a la gestión de la colaboración). El análisis de los resultados cuantitativos muestra la existencia de efectos significativos a favor de la condición que trabajó con mapas conceptuales colaborativos en el conocimiento adquirido durante la tarea colaborativa y en algunos de los indicadores de colaboración percibida. En la condición que elaboró resúmenes expositivos se observó un predominio de episodios de regulación dirigidos hacia la actividad cognitiva de la tarea colaborativa, siendo escasos, en ambas condiciones, los episodios de regulación social dirigidos hacia la colaboración dentro de las triadas.

1 Introducción

La investigación sobre aprendizaje colaborativo ha enfatizado la influencia que tienen diferentes herramientas tecnológicas digitales (por ejemplo, textos hipermedia e hipertextos, simuladores virtuales, tutoriales inteligentes), tanto para promover un mayor rendimiento en el aprendizaje como para enriquecer la dinámica de los intercambios entre los aprendices durante la actividad colaborativa (para una revisión, Dillenbourg, Järvelä, & Fischer, 2009). Asimismo, se ha señalado la conveniencia de organizar la colaboración a través de tareas abiertas que resulten activas, constructivas e interactivas -tales como por ejemplo, tareas de resolución conjunta de problemas indefinidos, indagación grupal para la generación y comprobación de hipótesis, elaboración colaborativa de diferentes productos de aprendizaje, entre otras-, y que favorezcan en los aprendices el despliegue y la explicitación de diferentes procesos cognitivos, metacognitivos y motivacionales y, sobre todo, la autorregulación y la regulación social durante la actividad colaborativa (Chi, 2009; O'Donnell & Hmelo-Silver, 2013).

En el aprendizaje colaborativo, la regulación social resulta un proceso clave no sólo para la generación de un producto colaborativo sino también para la gestión de los intercambios durante el desarrollo de dicha tarea (Hadwin, Järvelä, & Miller, 2011; Järvelä & Hadwin, 2013). Sin embargo, la investigación previa ha evidenciado que, por lo general, los estudiantes tienen dificultades para regular de manera conjunta las interacciones colaborativas (Acuña, López-Aymes, & Gabino-Campos, 2012; Rogat & Linnenbrink-Garcia, 2011; Summers & Volet 2010), y que la calidad y complejidad de estos procesos regulatorios puede verse afectado por el tipo de tarea y por el soporte tecnológico que se utilice en el contexto instruccional colaborativo (Järvenoja, Järvelä, & Malmberg, 2015).

Por tanto, la combinación "sinérgica" en la actividad colaborativa de soportes tecnológicos y tareas abiertas y constructivas, en principio, permitiría configurar un escenario instruccional "doblemente andamiado" que propiciaría una mayor regulación social, necesaria para la generación de una conciencia común acerca de las metas, la ejecución y el monitoreo de acciones coordinadas e interdependientes y la construcción conjunta y negociada de conocimientos que demanda la elaboración de un producto colaborativo (Järvenoja et al., 2015; Schoor & Bannert, 2012; Volet, Vauras, & Salonen, 2009). En tal sentido, una tarea de construcción colaborativa de mapas conceptuales para la adquisición de conocimiento utilizando materiales hipermedia -al reunir características de activas, constructivas e interactivas- tendría un abanico de mayores potencialidades para favorecer un mayor aprendizaje y también para elicitar diferentes procesos entre ellos los correspondientes a la regulación social. No resulta extraño, entonces, que los mapas conceptuales hayan sido utilizados como una estrategia instruccional para promover la comprensión y adquisición de conocimientos, tanto en situaciones de aprendizaje individuales como colaborativas (Chang, Sung, & Chen, 2001; Hilbert & Renkl, 2009).

A pesar de que la investigación sobre los mapas conceptuales colaborativos ha comprobado sus efectos positivos respecto a la construcción individual de mapas conceptuales y también frente a otras tareas de aprendizaje colaborativo (para una revisión, Basque & Lavoie, 2006; Gao, Shen, Losh, & Turner, 2007, Nesbitt & Adesope, 2006), algunos estudios han encontrado evidencias discrepantes en la comparación con otras tareas colaborativas de características similares, como la elaboración conjunta de resúmenes y pósters (Fechner & Sumfleth, 2008; Haugwitz, Nesbit, & Sandmann, 2010; van Boxtel, van der Linden, & Kanselaar, 2000). Estas investigaciones, sobre todo, se han detenido a analizar su influencia en el aprendizaje y a describir la calidad de los intercambios que se despliegan en dichas actividades colaborativas, siendo aún incipiente el estudio de los procesos de regulación social y de los niveles de colaboración que se alcanzan en esta clase de aprendizaje.

En este trabajo se estudian los procesos de regulación social en diferentes tareas colaborativas (mapas conceptuales y resumen expositivo) para el aprendizaje con multimedia sobre un tema de Psicología de la Comunicación. Concretamente se examina la influencia del tipo de tarea colaborativa en los procesos de regulación social del aprendizaje que ponen en juego estudiantes universitarios mexicanos cuando aprenden colaborativamente en triadas y se analizan también sus efectos en el rendimiento del aprendizaje y el nivel de colaboración que los estudiantes perciben en sus diferentes grupos. En primer lugar, se presentan los antecedentes teóricos y empíricos del estudio; en segundo lugar, se describe la metodología seguida y se da cuenta de los resultados obtenidos. Por último, se señalan algunas implicaciones para el empleo instruccional de los mapas conceptuales colaborativos.

2 El Aprendizaje Multimedia con Mapas Conceptuales Colaborativos y los Procesos de Regulación Social

Aprender colaborativamente con herramientas digitales, como por ejemplo textos multimedia e hipermedia, requiere que los aprendices desplieguen una serie de mecanismos cognitivos, metacognitivos y motivacionales de alta complejidad para procesar información textual y pictórica - de una manera integrada y constructiva – que se presenta en una secuencia no lineal (Jonassen, Lee, Young, & Laffey, 2005). A lo que se suma la necesidad de desplegar habilidades, también sofisticadas, para la planificación, la gestión y supervisión conjunta en el grupo, es decir, poner en juego procesos de regulación social para estructurar adecuadamente la colaboración (Molenaar, Sleegers, & van Boxtel, 2014).

Para hacer referencia a las actividades regulatorias grupales implicadas en el aprendizaje colaborativo, y distinguirlas de la autorregulación, algunos autores han propuesto el término regulacion social (Volet et al., 2009). Dicha regulación engloba a: - *la coregulación*, es decir, la regulación que se establece en una situación asimétrica en la cual uno de los miembros de un grupo, por disponer de mayor conocimiento y habilidades de regulación, orienta y apoya la competencia auoregulatoria de los otros integrantes en el grupo; y, - *la regulación socialmente compartida*, que hace referencia a los procesos regulatorios más avanzados y complejos que emergen cuando un grupo se regula de manera conjunta como un colectivo, en una situación simétrica, en la que puede construir de manera compartida una conciencia común acerca de las metas, las estrategias de monitoreo y de supervision y la gestión de los intercambios que supone una tarea colaborativa (Järvenoja et al., 2015; Volet et al., 2009). Ambos tipos de regulación social pueden dirigirse a diferentes aspectos de la actividad colaborativa. En tal sentido, Saab, van Joolingen y van Hout-Wolters (2012) han identificado dos grandes grupos de procesos regulatorios sociales que los estudiantes pueden desplegar: a) *regulación social de la tarea*, dirigida a regular las actividades cognitivas implicadas específicamente en la planeación, ejecución y supervisión de la tarea de aprendizaje, y; b) *regulación social del grupo o equipo*, asociada a la gestión y la coordinación de la colaboración entre los estudiantes que conforman dicho equipo. La formulación de preguntas, proporcionar explicaciones y clarificar procedimientos, son ejemplos de acciones relacionadas con la regulación de la tarea. Mientras que aquellas interacciones referidas a la organización y el manejo del grupo, tales como acordar los turnos para la participación y establecer acuerdos en el momento de negociación para la toma de decisions, son ejemplos de la regulación del equipo.

Algunos estudios empíricos acerca del aprendizaje colaborativo con multimedia han señalado que el nivel de aprendizaje que alcanzan los estudiantes depende en buena medida del tipo y la calidad de las interacciones que se ponen en juego dentro de los grupos (Azevedo, Winters, & Moos, 2004; Winters & Alexander, 2011). Por ejemplo, Winters y Alexander (2011) en un estudio acerca de los procesos regulatorios en el aprendizaje con hipermedia sobre el sistema circulatorio humano, observaron que las díadas integradas por estudiantes de preparatoria alcanzaron una mayor ganancia en su aprendizaje cuando se implicaron en procesos regulatorios colaborativos de alto nivel (e. g. establecer consensos, tomar notas y resumir informacion, valorar opiniones y expresar sentimientos relacionados con el conocer), asociados con comprensión conjunta, generar inferencias de alta calidad e implicarse en un procesamiento estratégico de la información.

Para elicitar los procesos de regulación social dirigidos tanto a la tarea como al equipo, es necesario proporcionar a los estudiantes apoyos adicionales, especialmente cuando estos estudiantes carecen de experiencia colaborativa. Al respecto, la construcción conjunta de mapas conceptuales como estrategia instruccional desempeñaría las siguientes funciones, de acuerdo con Cheng, Wang, & Mercer (2014): a) *focalización compartida*, ya que brindaría una estructura común para organizar las contribuciones de los estudiantes y orientar las discusiones; b) *refuerzo cognitivo*, al propiciar la activación de mecanismos de elaboración y negociación conjunta de significados; c) *soporte metacognitivo* , que posibilite la toma de conciencia de los conocimientos previos y la detección y reparación de los sesgos y lagunas que pudieran aparecer en el proceso de comprensión; d) *facilitación motivacional y emocional*, pues contribuiría a reducir la ansiedad y a generar emociones positivas relacionadas con metas internas de aprendizaje; e) *ayuda para la ejecución y la transferencia*, con el corresponiente beneficio para la mejora del rendimiento en el aprendizaje.

Asimismo, respecto al aprendizaje multimedia los mapas conceptuales colaborativos podrían cubrir otras dos funciones específicas: f) *ajuste apropiado de la carga cognitiva*, ya que siguiendo a Amadieu y Salmeron (2014), al menos teóricamente, el mapeo conceptual colaborativo generaría una reducción de la carga cognitiva ajena, permitiendo que el aprendiz emplee los restantes recursos cognitivos en el procesamiento específico de los elementos de información que se presenten en los materiales y de la interactividad que exigen el material multimedia (carga cognitiva intrínseca, que se mantiene constante) y, sobre todo dirija la carga cognitiva pertinente a los procesos mentales más sofisticados que requiere el aprendizaje multimedia colaborativo (Paas, Tuovinen, Tabbers, & Van Gerven 2003); g) *reconstrucción macroestructural*, posibilitando la conexión de conceptos que se encuentran alejados entre sí, además de la activación de los procesos inferenciales implicados en la construcción de una estructura global coherente de la información no líneal que presenta un multimedia (Amadieu, van Gog, Paas, Tricot, & Mariné, 2009).

Sin embargo, cuando se ha comparado la actividad colaborativa con mapas conceptuales respecto a otras tareas de características abiertas, constructivas y con similar nivel de interactividad los resultados han sido discrepantes. Por ejemplo, van Boxtel et al. (2000) no encontraron diferencias en el rendimiento en el aprendizaje que alcanzaron estudiantes alemanes de secundaria cuando aprendieron agrupados en díadas un contendio sobre física (electricidad) al elaborar colaborativamente mapas conceptuales y posters. Sin embargo, sí se observaron diferencias significativas en la calidad de las interacciones cuando los estudiantes realizaron una fase previa de preparación individual, sobre todo en la condición que trabajó con mapas conceptuales. En dicha condición se reportó un mayor número de discusiones sobre conceptos y una frecuencia más alta de episodios de negociación de conflictos

Por su parte, en su estudio sobre el aprendizaje de la química con mapas conceptuales colaborativos, Fechner y Sumfleth (2008) compararon una tarea colaborativa con mapas conceptuales con otra tarea de elaboración colaborativa de un resumen escrito. Previamente a la elaboración de estos productos los estudiantes de secundaria llevaban a cabo actividades de resolución de problemas que implicaban pequeños experimentos relacionados con la vida cotidiana. En los resultados no se observaron diferencias en el rendimiento que alcanzaron ambas condiciones en su trabajo en pequeños grupos, a pesar de que hubo variaciones en la manera en que los contenidos fueron revisados. Sin embargo, otro estudio realizado por Haugwitz et al. (2010) mostró que estudiantes con habilidades cognitivas por debajo del promedio alcanzaron un mayor rendimiento en una tarea colaborativa de elaboración de mapas conceptuales, si trabajaban en grupos donde interactúan con estudiantes que tenían también un bajo nivel de habilidades cognitivas. En este estudio participaron estudiantes de secundaria que aprendieron en grupos pequeños, durante varias sesiones, conocimientos sobre el sistema circulatorio humano a través de la elaboración colaborativa de mapas conceptuales y resúmenes expositivos escritos como estrategia para sintetizar lo aprendido en las sesiones. En los productos colaborativos aparecieron un mayor número de proposiciones válidas en la condición que elaboró mapas conceptuales, pero no se registraron diferencias en el aprendizaje de los grupos donde participaron estudiantes con habilidades cognitivas por arriba del promedio.

Se hace necesario, por consiguiente, contar con mayor evidencia empírica acerca de los efectos que tienen diferentes tipos de tareas colaborativas, entre ellas la construcción colaborativa de mapas conceptuales, en el rendimiento en el aprendizaje, el nivel de colaboración percibida en los grupos y sobre todo en la manera en que estos procesos de regulación social se despliegan en dicha tarea. En este estudio los participantes fueron agrupados en 15 equipos de tres integrantes. Cada triada fue asignada a una de las dos condiciones, a saber: elaboración colaborativa de un mapa conceptual y elaboración colaborativa de un resumen expostivo a partir de la información presentada en un documento hipermedia sobre un tema de Psicología de la Comunicación (Teoría del doble vínculo de Bateson). Se controló que no existieran diferencias significativas previas entre los grupos respecto a comprensión lectora, estrategias de regulación de la comprensión lectora y conocimientos previos en el dominio específico y en la elaboración de mapas conceptuales y resúmenes. Se examinó la calidad de los mapas conceptuales grupales y se valoró a través de un autoinforme el nivel de colaboración percibida por cada integrante de los equipos. Asimismo, se analizaron de manera cualitativa las características de los procesos de regulación social que pusieron en juego los estudiantes durante el trabajo colaborativo.

3 Metodología

3.1 Participantes

Los participantes fueron 45 estudiantes universitarios mexicanos de la asignatura Psicología de la Comunicación que cursan primeros semestres de carreras afines a las Ciencias Sociales (17 mujeres y 28 hombres). La edad media de los participantes fue de 18.5 años. Se agruparon en 15 triadas, cada una de la cuales fue asignada a una de las dos siguientes condiciones colaborativas: a) grupos que elaboran mapas conceptuales, b) grupos que elaboran resúmenes expostivos. Los participantes fueron instruidos previamente en la elaboración de mapas conceptuales y de resúmenes expostivos, en una sesión previa (gran grupo) de 60 minutos. La participación de los estudiantes fue voluntaria y como bonificación recibieron créditos en la asignatura.

3.2 Procedimiento

El estudio se llevó a cabo en dos sesiones. En la primera sesión (60 minutos), los estudiantes recibieron instrucciones sobre la elaboración de mapas conceptuales y de resúmenes expostivos y se llevó a cabo una práctica de modelado para la elaboración de ambos productos, sobre un contenido de Psicología (Psicología conductista) diferente al presentado en el material multimedia de la fase experimental, utilizando lápiz y papel. Asimismo, se aplicaron los instrumentos para controlar las variables pre-test referidas a pruebas de comprensión lectora y de regulación de estrategias de lectura. En la segunda sesión (60 minutos), se administró al inicio el cuestionario de conocimientos previos de dominio específico (10 minutos) y se explicaron las instrucciones para efectuar la tarea (5 minutos). Posteriormente, los grupos contaron con 30 minutos para la tarea de aprendizaje colaborativo, revisando el material multimedia y construyendo los mapas conceptuales y los resúmenes expositivos de acuerdo a la condición asignada. Finalmente, los participantes respondieron tanto el cuestionario de conocimientos sobre el dominio específico como el cuestionario de autovaloración de la colaboración percibida en los equipos. Durante la sesión de aprendizaje los estudiantes elaboraron los mapas conceptuales y los resúmenes expositivos con pluma digital (Smartpen Livescribe) que recogió también los intercambios verbales durante la tarea. Posteriormente, los mapas conceptuales fueron pasados a CmapTools (Cañas *et al*, 2004) mientras que los resúmenes y los intercambios verbales en los equipos se transcribieron usando un procesador de textos.

3.3 Materiales de aprendizaje

El material de aprendizaje consistió en un documento multimedia digital sobre La comunicación interpersonal y la teoría del doble vínculo de Bateson (1985). El multimedia se estructuró en 5 bloques de contenidos, que podían ser recorridos de manera no lineal, a saber: - teoría de los sistemas, - axiomas de la comunicación, - aportes y los campos de trabajo de Bateson, - teoría del vínculo y las paradojas, y - condiciones necesarias para que se presente el doble vínculo. En los diferentes bloques se combinaron textos escritos expositivos con textos en video audionarrados y podcasts. El documento multimedia se elaboró con el programa Prezi. Dado que la estructura del multimedia era no lineal, los participantes tenían la facultad de utilizarlo y explorarlo en el orden que ellos quisieran.

3.4 Instrumentos para la recolección de datos

Salvo los puntajes correspondientes a la calidad de los mapas conceptuales y los resúmenes colaborativos, el resto de las medidas se obtuvieron a partir de la aplicación individual de los distintos instrumentos a los participantes.

Para valorar las habilidades de comprensión lectora de los estudiantes se emplearon dos tareas. Por un lado, se aplicó la Batería Multimedia de Comprensión (versión abreviada) de Gernsbacher y Varner (1988), adaptada por Díez y Fernández (1997) que permite valorar los niveles de comprensión lectora. En esta prueba se pide a los alumnos que lean un texto informatizado “El regalo más preciado” y que, luego de la lectura, contesten ocho ítems con formato de pregunta de elección múltiple Cada pregunta acertada es contabilizada con un punto hasta alcanzar un máximo de ocho. Además, se administró una tarea de comprensión lectora de un texto expositivo corto y sencillo (111 palabras), en la que se solicita a los estudiantes que después de haber leído el texto durante 120 segundos, señalen las tres ideas principales de los tres párrafos que consta el texto y la idea global de dicho texto. El puntaje máximo de esta tarea es seis.

Para la valoración de estrategias de regulación de la lectura, se empleó la *Escala de Evaluación de la Autorregulación del Aprendizaje a partir de Textos* —ARATEX— (Solano et al., 2005). Consta de 23 ítems y la valoración se lleva a cabo a través una escala Likert, con cinco alternativas de respuesta, en relación con la frecuencia con la que realizan o no la actividad que se describe en el ítem (1= nunca; 5= siempre). Por ejemplo, "Cuando termino el texto, compruebo si lo he comprendido todo bien".

El nivel de conocimientos sobre el dominio específico tanto pretest como postest fue examinado por medio de un cuestionario con 10 preguntas sobre el tema de la Comunicación interpersonal, con respuesta de opción múltiple. Por ejemplo, uno de los ítems fue: "4. Señala la idea correcta: Según Watzlawick (1967), la comunicación puede ser… a) únicamente digital; b) únicamente analógica; c) analógica y digital; d) ninguna de las anteriores". El puntaje máximo que los estudiantes pueden obtener en este cuestionario es 10 puntos.

Para calificar el nivel de colaboración percibido por los participantes, se utilizó el Cuestionario de Colaboración elaborado por Chan y Chan (2011), y desarrollado con base a la noción de construcción colaborativa del conocimiento que plantea Scardamalia y Bereiter (2006). Este cuestionario comprende 12 ítems, valorados de acuerdo a una escala Likert de 5 puntos. Los diferentes ítems reflejan los 12 principios del aprendizaje colaborativo propuestos por Scardamalia y Bereiter (2006), de acuerdo a la experiencia de colaboración que tuvieron los estudiantes en sus respectivos equipos. Por ejemplo: "Nuestros puntos de vista y conocimientos pudieron ampliarse gracias al trabajo con los demás".

La calidad de los productos -es decir, mapas conceptuales y resúmenes expositivos- que se obtuvieron como resultado de la actividad colaborativa fue valorada de acuerdo a la xistencia y la corrección de las relaciones entre conceptos que se explicitaron en las proposiciones que construyeron los equipos. Se adaptó el procedimiento seguido por Haugwitz et al. (2010), ajustándolo al dominio de conocimiento específico (La comunicación interpersonal y la teoría del doble vínculo de Bateson). Para ello se construyó un listado de 15 proposiciones que reflejaban las ideas centrales del contenido presentado en el material multimedia (por ejemplo, Proposición 4: "La metacomunicación resulta clave como estrategia para salir de una situación de doble vínculo"). Se otorgó 1 punto por cada proposición elaborada correctamente.

Los intercambios verbales de los participantes fueron codificados de acuerdo con un sistema de análisis que combina diferentes propuestas cualitativas que describen la colaboración en un equipo (Castellanos-Ramírez & Onrubia, 2014: Järvelä, Malmberg & Koivuniemi, 2016; Saab et al, 2012, Volet, Summers & Thurman, 2009). La producción de los estudiantes fue segmentada en episodios, es decir, en una secuencia de enunciados que resultan significativas respecto a un contenido determinado (Van Boxtel et al., 2000). Es decir, un episodio consiste en un segmento de interacción en el que dos o más estudiantes regulan una acción colaborativa. Cada secuencia interactiva puede ser caracterizada de acuerdo con el sentido al que se dirige, a saber: a) *a la tarea de aprendizaje*, cuando se trata de conversaciones que aluden, ya sea a la actividad cognitiva (cuando hacen referencia a aspectos relacionados con el producto a elaborar o bien a la comprensión de los contenidos sobre los que versa dicho producto), o bien a la actividad metacognitiva (cuando aluden al establecimiento de metas, la planeación, el monitoreo de los progresos en la comprensión y en el desarrollo del producto colaborativo, y a la evaluzación de los logros alcanzados en la tarea); y, b) *al equipo*, o sea, a la gestión de colaboración en el equipo, como por ejemplo, la división de tareas, la organización de los intercambios y acuerdos respecto a los turnos de participación. Además, se identificó el tipo de regulación social que se establece en cada episodio según la forma en que se distribuye la participación de los estudiantes en la acción regulatoria, pudiendo ser: a) *coregulativa*, cuando un solo aprendiz ejerce y domina la regulación social, mientras el resto del equipo se limita a acompañar sus propuestas regulatorias; o bien, b) *compartida*, si múltiples integrantes del equipo participan conjuntamente en los procesos de regulación, observándose una interdependencia en el funcionamiento del equipo en ese episodio.

Para el análisis de datos se ha trabajado con un nivel de significación estadística de $p < 0.05$ y en dicho análisis se utilizó el programa informático Statistical Package for Social Science (SPSS) versión 15.0 para Windows. Para el análisis cualititativo se empleó el programa AtlasTi.

4 Resultados

Respecto a las variables de control, no se encontraron diferencias significativas entre las dos condiciones consideradas para este estudio (mapas conceptuales colaborativos y resúmenes expositivos colaborativos) en ninguna de las medidas de comprensión lectora, estrategias de regulación del aprendizaje ni en el nivel de conocimientos previos de dominio específico.

En el análisis cuantitativo de los resultados (con la prueba no paramétrica U de Mann-Whitney) no se mostraron diferencias significativas en la calidad de los productos colaborativos teniendo en cuenta la presencia y calidad de las proposiciones elaboradas tanto en mapas conceptuales como resúmenes expostivos (*U* de Mann-Whitney= 198.000; *Z*= -1.25; *p*=.28). Sin embargo, el análisis arrojó evidencia acerca de la existencia de diferencias significativas entre las dos condiciones respecto al rendimiento en el aprendizaje valorado a través del cuestionario de conocimientos, a favor de la condición que trabajó colaborativamente en la elaboración de mapas conceptuales. Es decir, que los estudiantes que trabajaron colaborativamente en la elaboración de un mapa concetpual obtuvieron puntajes más altos en el cuestionario de conocimientos (*U* de Mann-Whitney= 111.000; *Z*= -3.27; *p*=.001) que los estudiantes que elaboraron el resumen expositivo (Ver Tabla 1).

	Condición 1 (mapas conceptuales colaborativos)	Condición 2 (resumenes expositivos colaborativos)
Rendimiento en el aprendizaje		
Cuestionario Conocimientos	5.50 (1.69)	4.00 (1.22)
N° Proposiciones en productos colaborativos	6.37 (1.24)	5.71 (2.83)

Tabla 1: Medias y desviaciones estándares (entre paréntesis) de los puntajes en las variables referidas a rendimiento en el aprendizaje

Se encontraron diferencias significativas en la valoración total de los niveles de colaboración que percibieron los estudiantes, a favor de los grupos de la condición con mapas conceptuales colaborativos (U de Mann-Whitney= 137.500; Z= -2.621; p=.009). Asimismo, resultaron significativamente superiores los ítems referidos a Ideas mejorables (U de Mann-Whitney= 150.000; Z= -2.535; p=.011), Pensamiento complejo de alto nivel (U de Mann-Whitney= 156.00; Z= -2.351; p=.019), Diversidad de ideas (U de Mann-Whitney= 135.00; Z= -2.843; p=.004), Democratización del conocimiento (U de Mann-Whitney= 167.500; Z= -2.041; p=.041) y Avances simétricos (U de Mann-Whitney= 265.00; Z= -2.486; p=.013), a favor de los grupos que realizaron la tarea de elaboración de mapas conceptuales colaborativos (Ver Tabla 2).

	Condición 1 (mapas conceptuales colaborativos)	Condición 2 (resumenes expositivos colaborativos)
Ideas mejorables	4,25 (.67)	3.71 (.64)
Conocimiento comunitario y responsabilidad colectiva	4.37 (.71)	4.23 (.53)
Pensamiento complejo de alto nivel	4.41 (.71)	3.90 (.70)
Diversidad de ideas	4.16 (.81)	3.47 (.60)
Democratización del conocimiento	4.12 (.85)	3.66 (.73)
Agencia epistémica y negociación de significados	3.62 (.92)	3.09 (.70)
Discurso dirigido a la construcción de conocimiento	4.16 (.56)	3.90 (.30)
Evaluación concurrente	4.04 (.75)	3.85 (.85)
Avances simétricos	4.25 (.60)	3.85 (.35)
Usos constructivos de la información	3.04 (1.04)	2.85 (1.01)
Problemas auténticos e ideas concretas	4.25 (.67)	4.00 (.70)
Construcción de conocimiento generalizado	4.08 (.82)	3.85 (.91)
Total	4.06 (.44)	3.70 (.18)

Tabla 2: Medias y desviaciones estándares (entre paréntesis) de los puntajes correspondientes al nivel de colaboración percibida que obtuvieron los grupos de las dos condiciones

En la Tabla 3 se presentan los resultados obtenidos en el análisis cualitativo para identificar y caracterizar los episodios de regulación social en los equipos de ambas condiciones. En los grupos que elaboraron mapas conceptuales colaborativos se reconocieron un promedio de 10.5 episodios de regulación social; mientras que en las triadas que colaboraron en la elaboración de resúmenes expositivos el promedio fue inferior (alrededor de un episodio menos). En estos últimos equipos predominaron los episodios coregulatorios de la tarea dirigidos hacias sus aspectos cognitivos (poco más del 45 % de los episodios), en tanto que la actividad metacognitiva de la tarea fue tenida en cuenta en un 18 % de los episodios, considerandos ambos tipos de regulación social: coregulación y regulación compartida. Por su parte, en la condición con mapas conceptuales colaborativos, los episodios de regulación dirigidos a aspectos metacognitivos de la tarea se presentaron en un porcentaje un poco más alto (26 %, suman do los dos tipos de regulación social), siendo también mayor el porcentaje total de episodios de regulación compartida, en comparación con la condición resúmenes (una sumatoria del 50 % de episodios, frente a menos del 40 % de los episodios en los equipos que desarrollaron los resúmenes).

Regulación social		Condición 1 (mapas conceptuales colaborativos) *n*= 8 triadas		Condición 2 (resumenes expositivos colaborativos) *n*=7 triadas	
		f	%	f	%
Regulación de la tarea					
Coregulativa	cognitiva	24	28,58	30	45.45
	metacognitiva	13	15.48	7	10..61
Compartida	cognitiva	31	36.90	20	30.30
	metacognitiva	9	10.71	5	7.58
Regulación del equipo					
Coregulativa		5	5.95	3	4.55
Compartida		2	2.38	1	1.51
Total episodios		84 promedio 10.5	100%	66 Promedio 9.42	100%

Tabla 3: Frecuencias y porcentajes de los episodios de regulación social identificados en los grupos de las dos condiciones

5 Conclusiones

Los resultados encontrados en este estudio muestran los efectos positivos de la utilización de mapas conceptuales colaborativos en el aprendizaje, la colaboración percibida y en la regulación social, en tanto tarea de aprendizaje abierta, constructiva e interactiva. En comparación con otro tipo de tarea de aprendizaje de similares características -como es el caso de la elaboración de resúmenes colaborativos-, la construcción colaborativa de un mapa conceptual permitió que los estudiantes de estos equipos alcanzaran puntajes más altos en algunas medidas del rendimiento en el aprendizaje (cuestionario de conocimientos adquiridos luego de la sesión de aprendizaje) y también en varios de los indicadores de colaboración percibida (percepción de mejora de las ideas, pensamiento complejo, diversidad de ideas, democratización del conocimiento y avances simétricos, además, del puntaje total). Asimismo, se observaron diferencias en el tipo de procesos regulatorios que pusieron en juego los estudiantes cuando interactuaron en los equipos. Si bien en ambas condiciones hubo un predominio de regulación social dirigida a los aspectos cognitivos de la tarea colaborativa, los estudiantes que elaboraron mapas conceptuales colaborativos mostraron una mayor regulación metacognitiva. Además, se registraron en estos equipos un porcentaje más alto de episodios de regulación compartida.

Respecto al rendimiento en el aprendizaje, estos resultados son en parte consistentes con el trabajo previo de Haugwitz et al. (2010), a pesar de que no se haya replicado efectos diferenciales significativos en el número de proposiciones relevantes que se incluyeron en los productos colaborativos finales. Una posible explicación podría aludir a que en el mencionado estudio se trabajó en un entorno de aprendizaje con modelos físicos del sistema circulatorio humano y se utilizaron como materiales de aprendizaje tarjetas con información conceptual y relacional en las que se resaltaban los conceptos centrales y sus relaciones. Mientras que en este estudio se empleó material multimedia no lineal que podría generar algunos obstáculos para el procesamiento microestructural del contenido.

Asimismo, el hecho de que se haya registrado una mayor actividad regulatoria social de tipo metacognitivo en la condición con mapas conceptuales estaría en consonancia con el soporte metacognitivo que brindarían los mismos, tal como ha sido destacado por Cheng et al. (2014) y Hilbert & Renkl (2009). No obstante, cabe destacar que en ambas condiciones fue bastante bajo el porcentaje de episodios relacionados con la regulación de la colaboración en la tarea. Dato que también ha sido resaltado por la investigación reciente que reporta las dificultades de los estudiantes para poner en juego esta clase de regulación de manera espontánea (Rogat & Linnenbrink-Garcia, 2011; Summers & Volet 2010). Por consiguiente, sería conveniente desarrollar apoyos específicos para favorecer el despliegue de estos procesos vinculados con la gestión de las estructuras de colaboración en el trabajo grupal.

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Este trabajo integra una serie de estudios en progreso sobre colaboración y tecnologías digitales que se llevan a cabo en el marco del proyecto de investigación denominado "Gestión e innovación comunicativa en las organizaciones"de la Red Temática de Colaboración Académica "Gestión, Cultura y Comunicación en las Organizaciones", que cuenta con apoyo de PRODEP-SEP (México) DSA/103.5/15/11048 (UASLP-CA-232) y en el que participan el primer y el tercer autor.

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TEACHING EXPERIMENTAL SCIENCES USING CMAPTOOLS SOFTWARE FOR THE DESIGN OF KNOWLEDGE MODELS IN THE DEGREE OF PRIMARY EDUCATION TEACHING (DPET)

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Abstract. Experimental Sciences teaching corresponds to a broad area containing some of the core subjects of the Degrees of Infant and Primary Education Teaching at the Public University of Navarra. It belongs to the Teaching module and discipline and to the field of "Knowledge of the natural, social environment and its teaching", that is mandatory and consists of a total of 24 ECTS, of which 6 ECTS correspond to "Teaching of Natural Sciences" (TNS). This course is taught in the second half of the second year of the DPET. The aim of this work has been the preparation of this course as a Knowledge Model (KM) including several Concept Maps (CCMM) with different levels of deepness of the developed topics; and to check if this new way of presentation has a positive effect on students' satisfaction towards the teaching and the learning process (TLP) and if they see more meaning and coherence to the use of concept maps for learning if they are shown the complete course in "this significant language". Results show although it is difficult to change from the comfort zone at the beginning, when students start using CmapTools for creating their own Knowledge Models, they finish learning meaningfully and understanding better the whole course, find it easier to study for the evaluation and get to the domain of Knowledge by reaching basic, general and specific skills.

1 Introduction

The current educational landscape is undergoing a change not only in methodologies, teaching styles and teaching methods, but in terms of resources provided by technology. In 2001, González et al., warned the current context required a shift from the predominant positive-behaviorist model that favored mechanical rote learning, which was an ideal breeding ground for the generation of misconceptions (González, Morón & Novak, 2001), towards another cognitive-constructivist, which would stimulate meaningful learning. This new paradigm would allow students to build and master knowledge, therefore becoming more creative and critical (Meichembaum & Biemiller, 1998). In this century, we face a number of challenges: some come from the so-called society of knowledge and information, which can be summarized in a change of an ethic of obligation for another of responsibility, widespread use of information and communication technologies, the so called ICT, and the requirement of a school, in generic terms, of quality, accountable to society and which encourages students to get universal literacy, motivation to learn and discipline for long life learning. Others come from the implementation of the European High Education Area (EHEA) which implies a change in the model of teaching / learning, shaping a new role not only for teachers, but also for students, and affects the redesign of the subjects contained in the called Teachers' Guides (Zabalza, 2004). In this new paradigm, students play an active role not only learning about the product but through the process itself (metacognition). The teacher's responsibility is primarily to create conditions that facilitate students the ability to transform information in useful, substantive and transparent knowledge, which is incorporated and well-articulated in their long-term memory.

The assessment in this new educational scenario, plays a key role in promoting continuous improvement, consolidating the strengths and correcting weaknesses. Such evaluation should take two dimensions (Novak, 1998): first measure what students know and secondly, assess how their cognitive structure has changed in relation to such knowledge, by evaluating the necessary conceptual change (Posner, Strike, Hewson & Gertzog, 1982). It is noteworthy in this model, the teaching dimension (emphasis on teaching or what is taught) is subordinated to what it is learnt and how students learn better and get skills for their future. Under this focus, the teaching-learning process (TLP) changes into the learning-teaching process (LTP). That is to say, education is a concept based in learning and student-centered. Primary and Secondary Schools as well as Universities have to use their potential in order to promote teaching/learning quality, define adequate learning results and point the way to get them (Pérez de Villarreal, 2015).

The theoretical framework of Ausubel, Novak and Gowin is suited as well as their methodological application through the construction of Concept Maps (CCMM) and Gowin's epistemological "Vee" diagram. CCMM and Vee diagrams are metacognitive tools which help enhancing the conceptual change nowadays needed in the way of educating in knowledge. In the 80's, Ausubel developed his theory of meaningful learning remarking that: the student must demonstrate a willingness to relate substantial and not arbitrarily the new material in his cognitive structure, as the learning material is potentially significant for him; this is, relatable with his knowledge structure on a non-arbitrary basis (Ausubel, 1983). Substantial and not arbitrary relationship, should be understood in the way that the ideas relate to an existing specifically relevant aspect of the cognitive structure of the student, as an image, a significant symbol, a concept or proposition. This means that in the educational process, it is important to consider what the individual already knows, so that he can establish a relationship with what he must learn.

This process takes place if the student has in his cognitive structure concepts, such as the following: stable and defined ideas and propositions, with which new information can interact. The Vee heuristic technique was invented by Gowin (1981) as a strategy to solve a problem or to understand a procedure and could be applied in basic and secondary education and university. Gowin proposed the Vee diagram as a tool to be used to critically analyze a research, understand an experiment in the laboratory, as a teaching method for promoting meaningful learning and elicit knowledge. According to Guardian and Ballester (2011), Gowin's Vee is a heuristic and metacognitive technique that illustrates and facilitates learning through theoretical and methodological elements that interact in the process of building knowledge for solving a problem. Therefore, the Vee is considered a technique used to learn to learn (and think). This is a diagram in a V, which is represented visually as a knowledge structure. Knowledge refers to objects and events in the world. We learn something about it when posing questions under concepts organized into sets of principles (which explain how objects and phenomena behave) and theories, from which we can plan actions (experiments) that will lead us to answer the initial question.

Novak (1982) shows that CCMM and Vee diagrams positively influence teaching, learning, curriculum and environment, and these four elements, along with the feelings and actions, become part of any meaningful educational experience.

The Vee diagram was designed as a heuristic tool that interrelates the knowledge, know-how and knowledge to be; for example, the contents related to concepts, procedures and attitudes (scientific competences); and also allows integrating everyday knowledge with scientific knowledge, being considered highly significant. (Ausubel, Novak & Hanesian, 1983; Novak & Gowin, 1988; Barriga & Hernandez, 1999; Sánchez, 1999; Ontoria, 2001).

Authors such as Anta (2001), have conducted research related to the usefulness of the schemes and specifically of Vee diagrams in different disciplines, educational levels and national and international academic spaces. All agree on the usefulness of this tool for the meta-cognitive development of students.

The five original questions proposed by Gowin (1981) to apply to any statement or document in which some knowledge is present are: i) Which is the decisive question?, ii) Which are the key concepts?; iii) Which are the research methods used ?; iv) Which are the main statements about knowledge? and v) Which are the main value judgments?

These five questions summarize the construction of knowledge, for understanding to solve the posed problem. The model has been adapted to different sciences and areas of knowledge for its effect on the production of meaningful learning; one of the most important models were applied by Moreira (2006) in Brazil, with considerable success. In some of his articles, he shows the application of the Vee, especially in problem solving activities in secondary and university education.

For Moreira (2006), meaningful learning is a process through which the same information relates, in a non-arbitrary and substantive manner, with an important aspect of the cognitive structure of the individual. Thus, meaningful learning is characterized by interaction, and not a simple association between specific and relevant aspects of the cognitive structure and new information. Meaningful learning involves questioning and requires the personal involvement of the learner; this is, a reflexive attitude towards the process itself and the content learning object, tending to ask ourselves what we want to learn, why and why significantly learn it (Moreira, 2010). Thus arises a new contribution, which is its criticality. Through critical meaningful learning it is how students can be part of their culture and at the same time not be subjugated by it, by its rites, myths and ideologies. (Moreira, 2005: 88).

For Gowin (1981), meaningful learning takes into account the important influence of emotional experience in the process leading to its development. But it is not just a result, but a process in which meanings are shared; this idea is widely developed in the postulated educational theory. For him, "teaching is consumed, when the meaning of the instructional material the student grasps, becomes the meaning that the teacher intended that this material should have for the student." (Gowin, 1981). The essential contribution of Gowin, is the establishment of a triadic interaction between teacher / student / educational curriculum materials aimed at sharing meanings, without which, in any way, meaningful learning (Rodríguez, Caballero & Moreira, 2010) would be obtained. In addition, Gowin defines the responsibilities of the different actors in the process of learning; for example, the educational curriculum materials, should follow some pedagogical and didactic orientations (Zufiaurre & Belletich, 2014; Pérez de Villarreal & Belletich, 2015; Belletich, Pérez de Villarreal & Zufiaurre, 2013), which show the importance of the design and programming of educational processes, clearly explained in the Instructional Design Theory, considering particularly important the design approach in science education. According to Godino *et al*., (2013), the learning research based in design (design research or design of experiments) is part of a family of methodological approaches, that takes place in the natural context of a class. It uses systematically design, analysis tools and instructional strategies. Thus, the research includes, in successive cycles, both the design and implementation in the context of a class and the evaluation of the results. In this theory, three main elements may be considered in all teaching sequence: planning (programming), execution (activities) and assessment (acquisition of skills or competencies). Also, other research studies (González, 2008; González, Morón & Novak, 2001; Novak, 1998) show wide evidence, demonstrating the great potential of CCMM to improve teaching, both for the diagnosis of students' prior knowledge and for the design and implementation of consistent curriculum and instruction by the teacher. The three components of the Instructional Design Theory should be included, all under the perspective of the objectives: Programming (prior organization of the number of weeks provided for theoretical instruction and the number of weeks aimed at practical sessions in the spring semester); Execution (activities to develop: initial, processing and summary); Assessment (skills developed in each activity).

Since we wanted our students to start using this methodology, we considered we should provide the information in a consistent manner with what was being taught; in this case, the course of TNS which corresponds to the second semester of the second year of the DPET at the PUN.

2 Material and Methodology

2.1 Design of the subject TNS

In this study, we aimed to implement a new system of course presentation forwarded to students of the DPET, centered in the subject "Teaching of Natural Sciences" (TNS). This subject belongs to a broader area, "Teaching Experimental Sciences" and specifically to the field of "Knowledge of the natural, social environment and its teaching". TNS is compulsory in the curriculum of the PUN, and consists of a total of 6 ECTS (European Credit Transfer System) from a total of 24 ECTS (in the whole area). It develops the following topics:

- Teaching and learning sciences today.
- Science and modeling.
- Physical systems.
- Matter and its changes.
- Living things and their environment.
- The human body.
- School scientific activity: key ideas, curriculum, previous ideas of students and media for their evolution.
- Resources for teaching Studies: field trips, ICT and laboratory.
- Fundamentals and the application of the scientific method in teaching and learning about the natural environment.
- Theory to design environmental exploration projects.
- Inquiry learning.
- Guidelines for preparing proposals and integrated educational projects based on the Natural Environmental Knowledge (NEK) area which are called Instructional Modules (IM).

TNS subject was developed according to the Curriculum of Primary Education in Navarra (Spain) and aims to expand and deepen the content and necessary skills to teach the subject "Natural Environmental Knowledge" (NEK), which is compulsory in the three cycles (each cycle comprises two courses) of Primary Education. In TNS, students will work specially on scientific ideas they will develop in NEK in Primary Education ("content of school science"), and how to approach the teaching and learning process (TLP) by promoting constructive and inquiry activities. Some of these activities integrate the use of Information Communication and Technology (ICT) Tools, such as CmapTools software (Cañas *et al*, 2004) from IHMC (Institute for Human Machine and Cognition, Florida, USA) for their use in the social construction of knowledge.

2.2 Objectives of TNS:

The objectives of the TNS course are:

- To identify and discuss the contents of basic school science and the key ideas developed in Primary Education.
- To deepen the perspective of teaching and learning in school science activities that integrate the construction, inquiry, research and communication.
- To know, propose and evaluate activities for the development of scientific competence in Primary Education.

2.3 *Skills*

The skills students have to acquire at the end of the course are the following:
Basic skills (BS):
BS1 - That the students have demonstrated knowledge and understanding in a field of study that part of the basis of general secondary education, and is typically at a level which, although it is supported by advanced textbooks, includes some aspects involving knowledge of the forefront of their field of study.
BS2 - That the students can apply their knowledge to their work or vocation in a professional manner and have competences typically demonstrated through devising and defending arguments and solving problems within their field of study.
BS3 - That students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues.
BS5 - That students have developed those skills needed to undertake further studies with a high degree of autonomy.
General skills (GS):
GS1 – To know the curricular areas of Primary Education, the interdisciplinary relationship between them, the evaluation criteria and the body of didactic knowledge regarding the respective teaching procedures and learning.
GS2 – To design, plan and evaluate teaching and learning processes, both individually and in collaboration with other teachers and school professionals.
GS7 – To collaborate with different sectors of the educational community and the social environment, assuming the educational dimension of the teaching profession and promoting democratic education for active citizenship.
GS8 – To maintain a critical and autonomous relationship with respect to knowledge, values and public and private social institutions.
GS9 – To assess individual and collective responsibility in achieving a sustainable future.
GS10 – To reflect on classroom practices, to innovate and improve teaching, acquiring habits and skills for independent and cooperative learning and promoting it among students.
GS12 – To understand the role, possibilities and limits of education in today's society and the core competencies affecting Primary Education schools and its professionals. To get to know models of quality improvement with application to schools.
Transversal competences (TC):
TC2 – To demonstrate proficiency in Spanish and, where appropriate, in Basque equivalent to level C1 of the "Common European Framework of Reference for Languages: learning, teaching, assessment" of the Council of Europe.
Specific competences (SC):
CE1 – To know the objectives, curriculum content, the meaning of the areas and the organization, methodology and criteria for the assessment in Primary Education.
CE2 – To design, plan and evaluate teaching and learning in response to interdisciplinary and disciplinary criteria with other professionals.
EC7 – To promote cooperation, motivation and desire to learn, and actively participate in school projects.
EC9 – To acquire habits and skills for autonomous and cooperative learning to promote the active involvement of students in their social and personal development.
CE10 – To reflect regarding classroom practices to innovate and improve teaching, and refer to the operation of the basic psychological processes, pedagogical models and disciplinary criteria of the stage.
CE12 – To actively organize the teaching and learning of the contents of Primary Education from the perspective of skills development. To get to know models of improvement quality.
CE14 – To contextualize the teaching action in the political, social, and pedagogical changes, fostering democratic education and development of active citizenship for achieving a sustainable future.

2.4 *The structure of TNS in the didactic guide of the Public University of Navarra (PUN)*

This course consists of 6 ECTS which correspond to 150 hours/ work for the student, of them, 40% (60 hours) belong to classroom and lab teaching (with theoretical and practical sessions) and 60% (90 hours), to personal study. TNS caters to the teaching sequence consisting of: Programming, Implementation and Evaluation.

2.4.1 Programming and organization:

The number of hours aimed at teaching, are spread over 15 weeks, leaving the last week for the presentation of the IM, in which the students (in groups of 4-5) have to develop a selected topic contained in any of the 5 blocks of the area of Natural Sciences, inside the Curriculum of Primary Education in Navarra (see BON, number 174, September 2014, pp. 7-16).

2.4.2 Implementation

- *Structure of the theoretical and practical content:*

The agenda is structured in three blocks, taking into account the philosophy (cognitive / constructivist) underlying the approach of the subject. Firstly, Block I was designed to lay the theoretical foundations that allow students to learn meaningfully and build knowledge (through research related processes), to provide them with the appropriate tools to carry out these tasks. Also, in Block II, it is intended that the students learn the curriculum of primary education, with regard to Environmental Awareness and applied in Navarra (Spain). In Block III, all theoretical and practical knowledge acquired in Block I, is used for the development of the IM based on a selected block of the Natural Science curriculum, evidencing the knowledge acquired by the students and their domain, which is shown through public presentation of the model.

BLOCK I:

Item 1: Analysis of educational models: traditional (behaviorist, positivist) and progressive (cognitive and constructivist)

1.1. Theories of teaching / learning of Ausubel, Novak and Gowin, for the teaching of natural sciences

1.2. Fundamental principles thereof

1.3. Theory of conceptual errors

Item 2: Instructional Techniques for improving the teaching-learning environment

2.1. Concept maps and meaningful learning of the natural environment

2.2. The UVE knowledge, meaningful learning environment, building knowledge and research process of the natural environment

BLOCK II:

Item 3: Curriculum of Primary Education in Navarra (Spain). Science: objectives, content and evaluation criteria

3.1. Learn about physical systems in primary education. What are the key ideas? What does the curriculum say? What previous ideas do students have? How can we evolve?

3.2. Learning about matter and its changes in primary education. What are the key ideas? What does the curriculum say? What previous ideas have the student? How can we evolve?

3.3. Learn about living things and their environment in primary education. What are the key ideas? What does the curriculum say? What are the previous ideas students have? How can we evolve?

3.4. Learn about the human body in Primary Education. What are the key ideas? What does the curriculum say? What are the previous ideas students have? How can we evolve?

BLOCK III:

Item 4: Development of a curriculum and instructional design regarding selected aspects of Experimental Sciences

4.1. Guidelines for the development of a curriculum and instructional design in relation to the Natural Environment

4.2. Developing the corresponding knowledge

4.3. Public presentation of the Instructional Module (IM)

- *The teaching methods* used are:

- Masterly exhibition (purely theoretical content) in large group (44 students). In this sessions, the teacher raises previous ideas concerning the particular issue to address in order to detect students' prior knowledge; then, she leaves a time (about 20 minutes) for students to comment and discuss between them. After this time, they put in common and the teacher comments the concept maps or presentations referred to the particular issue, in order to solve any questions that will arise students, avoid misconceptions and at the same time, refresh prior knowledge.
- Practical and laboratory exercises in medium groups (24 students in one medium group and 20 in the other). For the development of the practical training, students are gathered in small groups of 4-6 individuals, which are held throughout the semester, managing themselves and distributing the work to be done. In this sessions, students perform practical exercises related to theoretical contents, or where appropriate, develop laboratory experiments, perform dramatizations, write reflections on the research method or methodologies, read research articles, play trivial based on TNS contents, and finally publicly expose their Instructional Module (IM).
- Face tutorials: they are designed to answer questions and establish guidelines and tasks for self-study.

2.4.3 Assessment

ASSESSMENT	% OF VALUE COMPARED TO WHOLE COURSE	RETRIEVABLE (%)
Asistance and participation	10	0
theoretical work, practical exercises, reviews, synthesis	20	15
Instructional Module (containing KM)	30	15
Oral or written tests	40	40
TOTAL	100%	70%

Table 1: Table showing TNS Assessment

2.5 Vee diagram

In order to clarify the structure and design of the course, a Vee diagram was developed so that we could contemplate the steps to follow and it could serve as a guide for obtaining the initial goals (see 2.1).

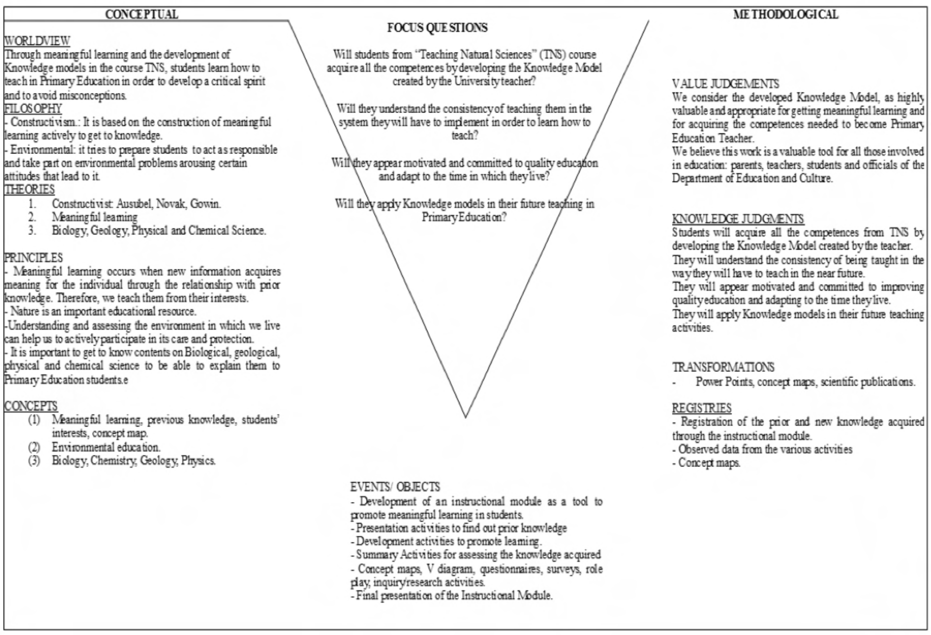

Figure 1. Vee diagram of the TNS course with the focus questions highlighting the objectives of the work.

As mentioned in the introduction, Gowin (1981) developed this heuristic tool which incorporates 12 elements for the process of knowledge construction, including not only the steps of the scientific method, but also the conceptual knowledge represented on the left of the Vee, including the world view, philosophy, theories, principles and concepts, guiding the research. The Vee diagram (González, 2008) is a method which can help students and educators to analyze the structure and meaning of the knowledge they try to understand (metacognition) and allows the incorporation of new knowledge to the cognitive structure the student already has transforming the learning process into a meaningful one. The shape of "V", is not an accident, but it was designed to house on the left side the conceptual / theoretical (thinking) part, and on the right side, the methodological / practical (doing) part, both directed to refer to objects and events in the process of knowledge production.

The V diagram (Figure 1) has been designed in order to answer the following focus questions which represent the objectives of this work and to serve as a guide for the teacher throughout the whole teaching / learning process:

- Will students from "Teaching Natural Sciences" (TNS) course acquire all the competences for becoming Primary Education Science Teachers, by developing the Knowledge Model created by the University teacher?

- Will they understand the consistency of teaching them in the system they will have to implement as future teachers (constructivism), in order to learn how to teach and avoid the positivist or behaviorist didactic style in which they were taught?

- Will they appear motivated and committed to quality education and continue their "long life training", adapting to the time in which they live and leaving the comfort zone of repeating merely transmissive models and reception learning?

- Will they apply Instructional Modules (IM), which contain Knowledge Models (KM), in their future, for creating their own teaching material conceptually transparent when becoming Primary Education Teachers?

2.6 Inquiry

An inquiry was designed for students to check the usefulness of the presentation of TNS course (as a Knowledge Model using CmapTools software) and if it helped to answer the focus questions of the Vee diagram, which are really the goal of this work. This survey was answered anonymously by the students attending class in a particular day (30 students).

3 Results

3.1 Development of a Knowledge Model (KM)

The aim of this work has been the preparation of this course as a KM, including several Concept Maps (CCMM) with different levels of deepness of the developed natural science topics throughout the course of TNS.

A KM consists of a set of CCMM and digitized resources associated therewith, all in relation to a particular topic, in our case, related to TNS. It can also be defined as a collection of CCMM linked to a root map representing increasing levels of specific differentiation. Where appropriate, associated resources (photos, documents, videos, etc.) that are designated generically with graphical icons, are linked to the maps' concepts.

In general, CCMM can be defined as diagrams which indicate the relationships among key concepts or nouns and it is a technique proposed and developed by Joseph Novak (Novak and Gowin, 1988). The relationships are shown by linking words which are normally verbs, adverbs or prepositions, that make a whole sense to the sentence created when linking concepts, which is called proposition. CCMM are powerful tools for describing structures of disciplinary knowledge through conceptual hierarchies or meanings, from general to more specific rules and they are dynamic creatures which evolve together with the knowledge of the student. It represents clearly as if it were a mirror, the cognitive structure of an individual; so it means, it is different in each one.

Graphic icons linked to concepts of the CM can be displayed by clicking on them and then on the writing that appears. Information shall be so displayed in the interface. The original map with the associated resources can be accessed via CmapTools (Cañas *et al*, 2004; Novak & Cañas, 2006).

Subordinated CCMM allow the user, to navigate through this model. KMs are useful tools to create meaningful learning and avoid conceptual misconceptions by means of the elaboration of CCMM and for their construction.

In the following figure, we show the root map of the KM of the course "Teaching Natural Science (TNS)".

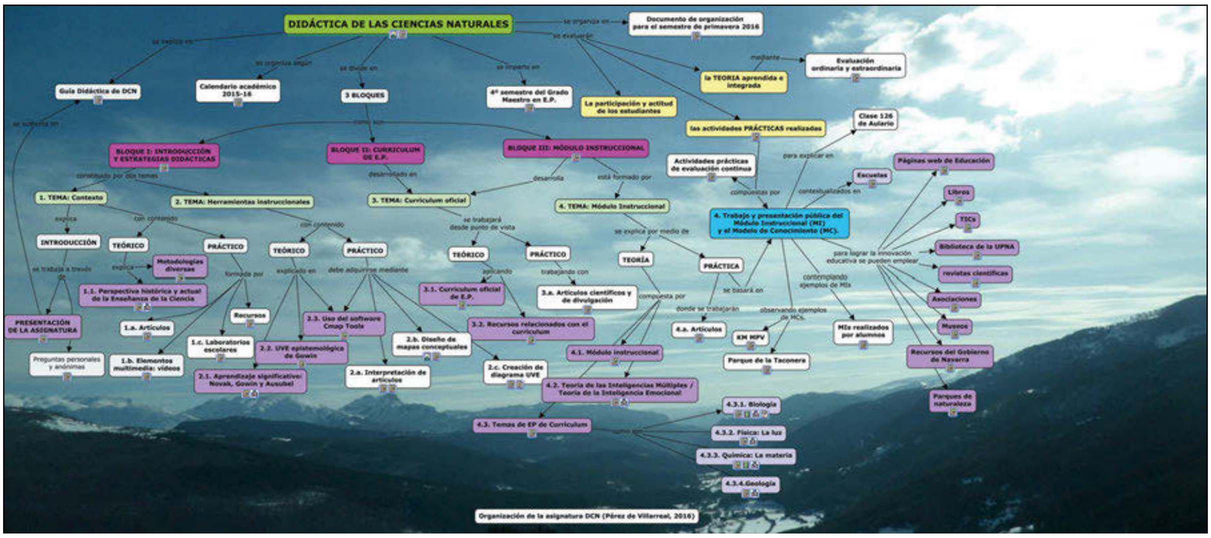

Figure 2. KM of the course "Teaching Natural Science" which contains all the links and resources associated, students have access to. Available at: http://cmap.unavarra.es/rid=1PSMC7T5F-18M53PG-2XD/DCN%20MPV.cmap.

From this root map we can have access to all the theoretical and practical content of TNS course. The map is structured in the same way as the teaching guide, containing three blocks with the correspondent theoretical and practical content.

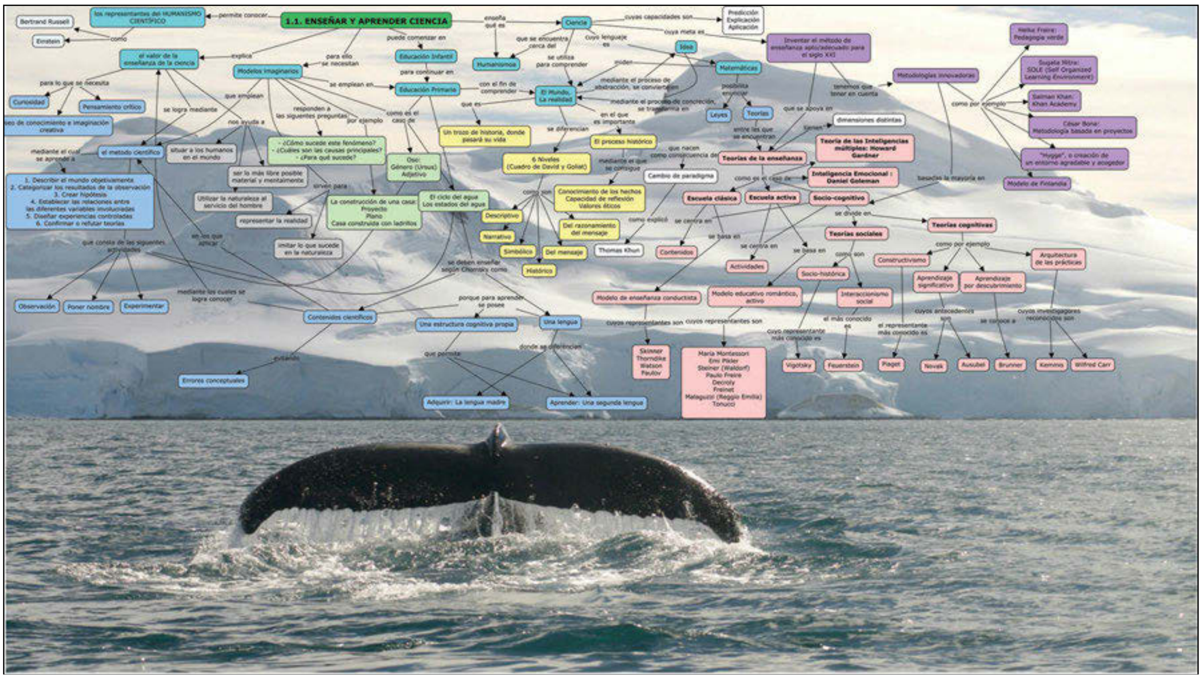

Figure 3. CM of the first theoretical topic of the first Block of: "Teaching and Learning Science" course.

This is the first CM showing the theoretical content of the first topic of the first block. In general, it summarizes part of the theories underlying TNS. It contains videos and research articles as well.

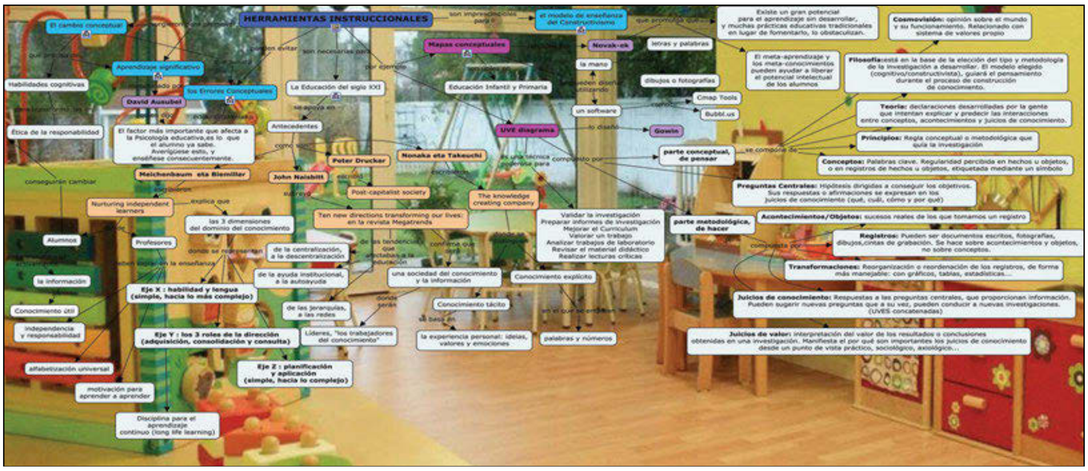

Figure 4. CM of the second theoretical topic of the first Block: "Instructional tools", which contains links to other submaps.

By means of this CM, we show the usefulness of the heuristic tools in TNS. Not only Vee diagram is explained, but also, the design of concept maps for the preparation of transparent and substantial teaching material.

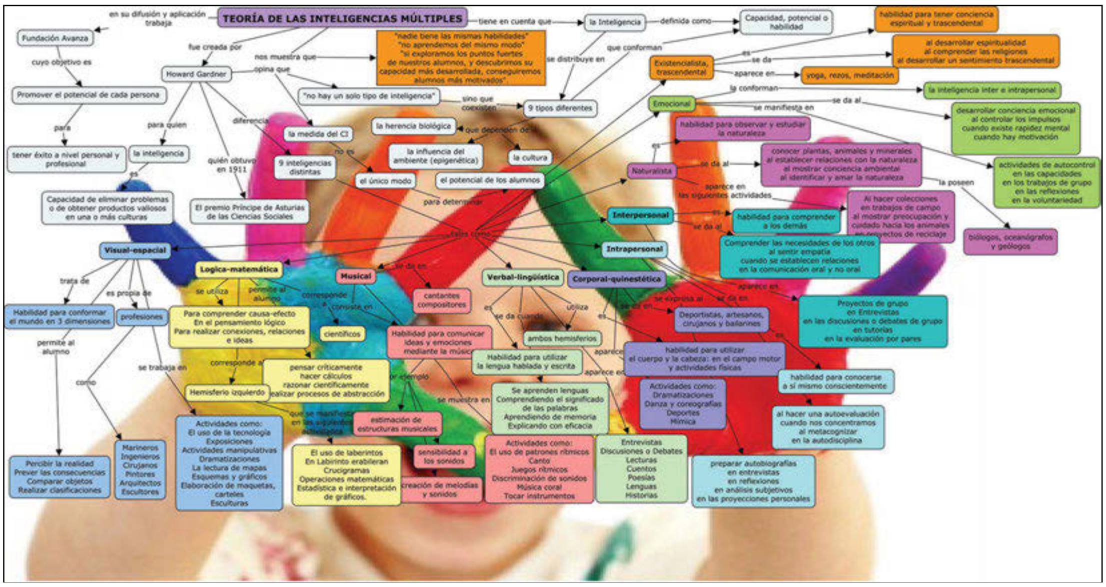

Figure 5. CM of a transversal theoretical topic related to the second Block: "Theory of Multiple Intelligences" to highlight the importance of developing teaching strategies taking into account the emotions, interests and abilities of students.

In both maps (Figure 5 and 6) we show both theories related to the abilities of human beings and to the consideration Intelligence is not only a matter of IQ (Intelligence Quotient); in the one side, the Theory of Multiple Intelligences developed by Howard Gardner (1983), and in the other side, the Emotional Intelligence, by Daniel Goleman (1996). Both theories, although different, agree on the idea of the importance of managing emotions, not only for learning, but for personal and professional development of the individuals.

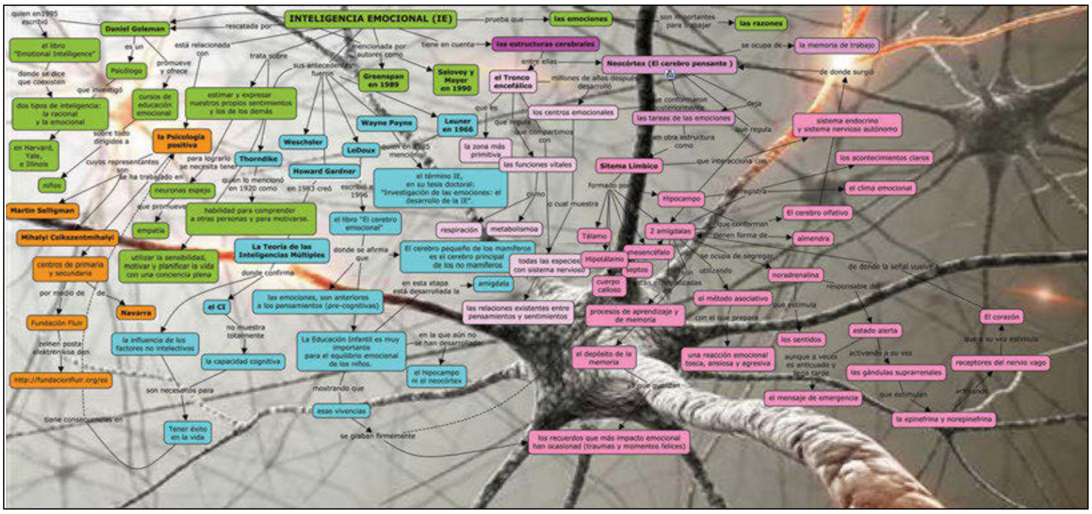

Figure 6. CM of a transversal theoretical topic related to the second Block: "Emotional Intelligence" inspired in Daniel Golemans's work and which also adds submaps.

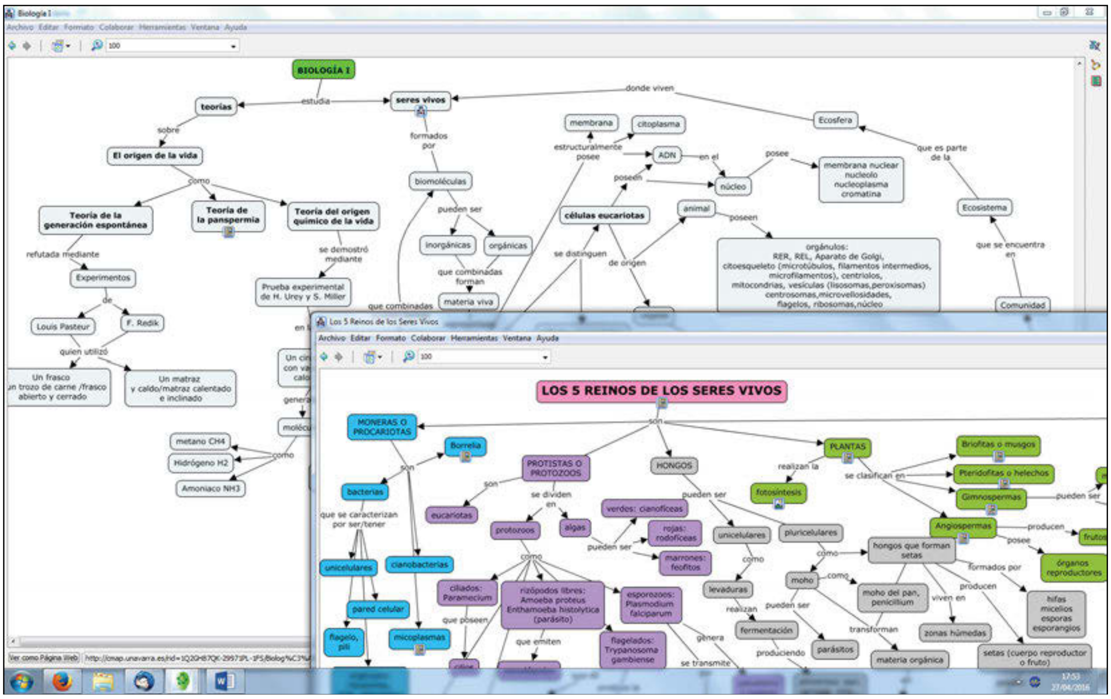

Figure 7. CM of the Biology contents to refresh previous ideas to TNS students.

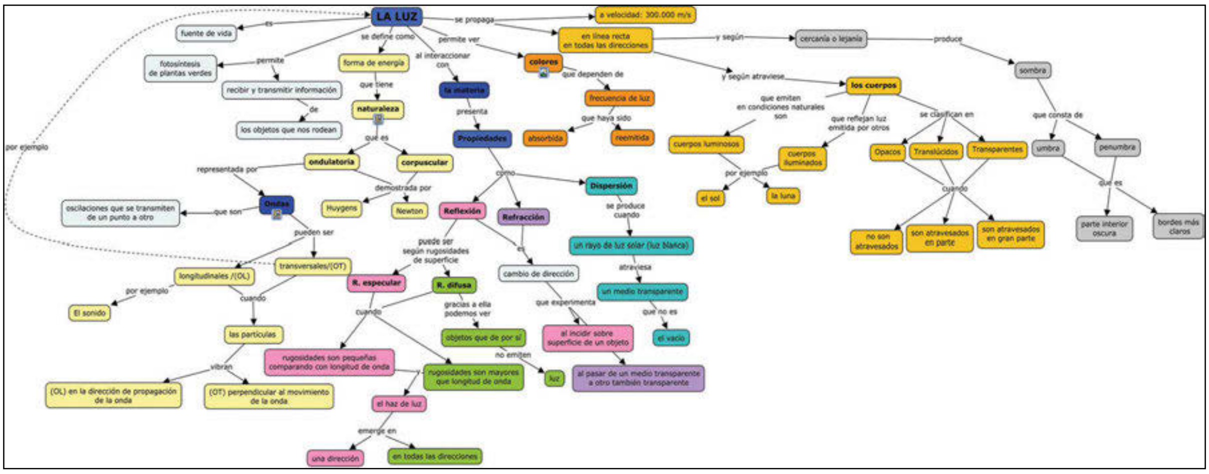

Figure 8. CM of Physical contents on the topic “The nature of light”.

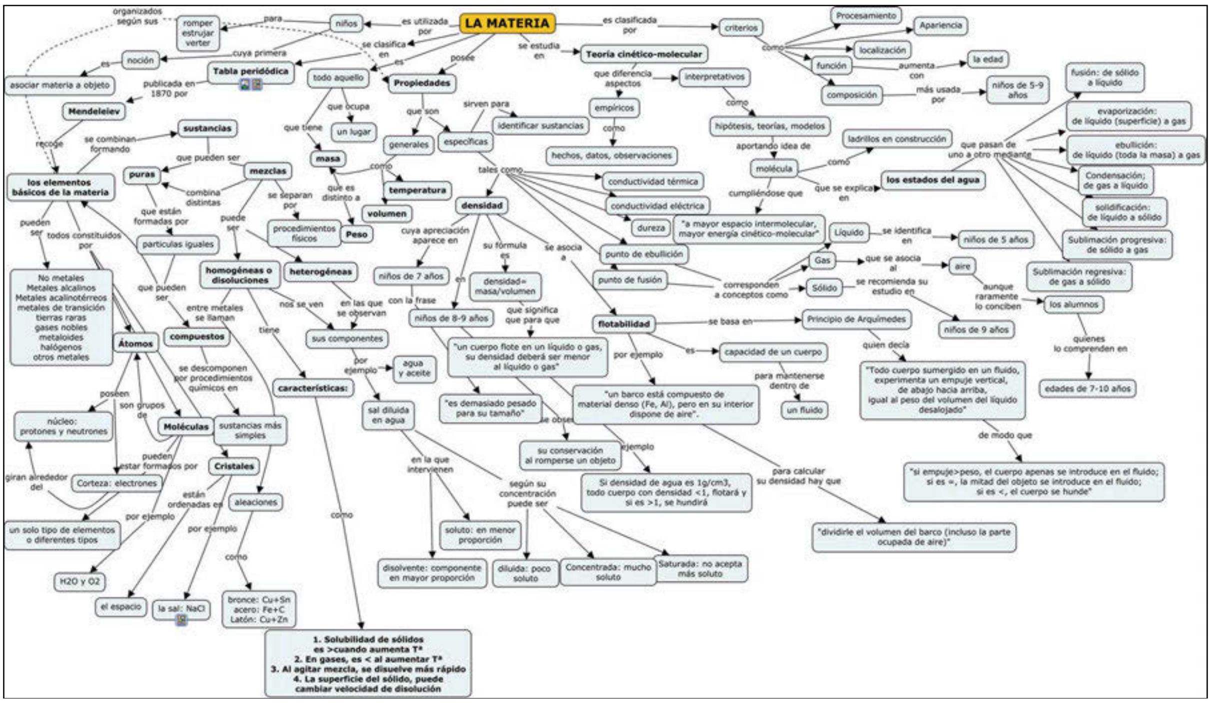

Figure 9. CM of Chemical contents on the topic “The matter”.

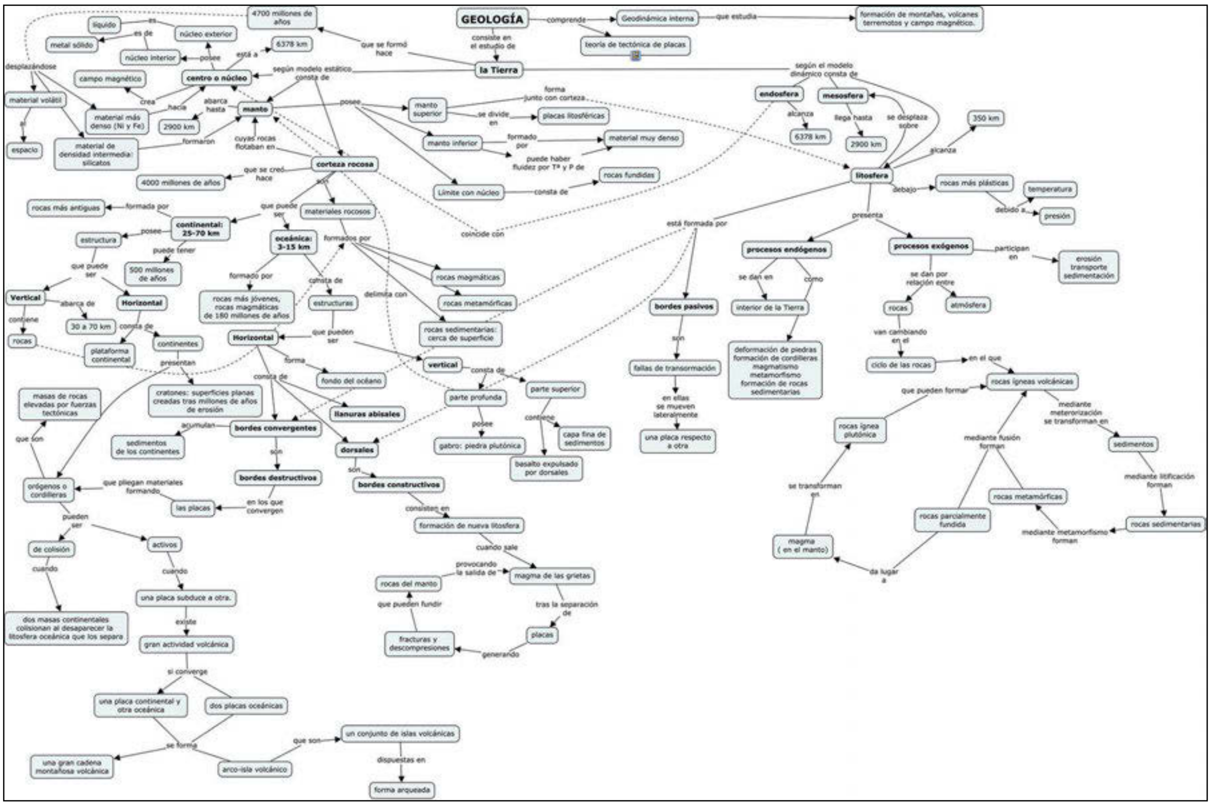

Figure 10. CM explaining the contents of the topic "Geology" in order to refresh students' previous ideas.

TNS subject is raised to refresh and evolve didactically (didactic transposition) previous knowledge of 5 blocks of contents included in the curriculum of Primary Education in Navarra (see BON), which are:

- Introduction to scientific activity
- The human body and health
- Living beings
- Matter and Energy
- Technology, objects and machines

Students work in small groups and select the most attractive block for them as a group. This is a strategy to encourage motivation. Then, they evolve the selected block, contextualized in a particular grade of Primary Education (6 to 12-year-old students), in the last practical work, which is the creation of the Instructional Module (IM), using CmapTools. The IM must include a Knowledge Model (KM) and for its creation and development, students need to have some basic scientific knowledge provided by the CCMM we designed for them and which are showed in this sequence (Figures 7, 8, 9 and 10): Biology (Living beings and human body); Physical contents (The nature of light); Chemical contents (Matter and energy) and Geological Contents (the structure of the Earth and technology). By developing the instructional module, we ensure that students work independently and acquire the skills for designing their own teaching materials in the future.

Below, we show the typical root map of an IM (Figure 11), containing the theoretical framework of the TNS subject, the KM of the selected block and the Instructional Design which includes the principles of programming, implementation and assessment which are represented by the following concepts: contextualization, organization or programming in a timetable, objectives, contents, methodologies, activities (initial, processing and summarizing), assessment, glossary and references.

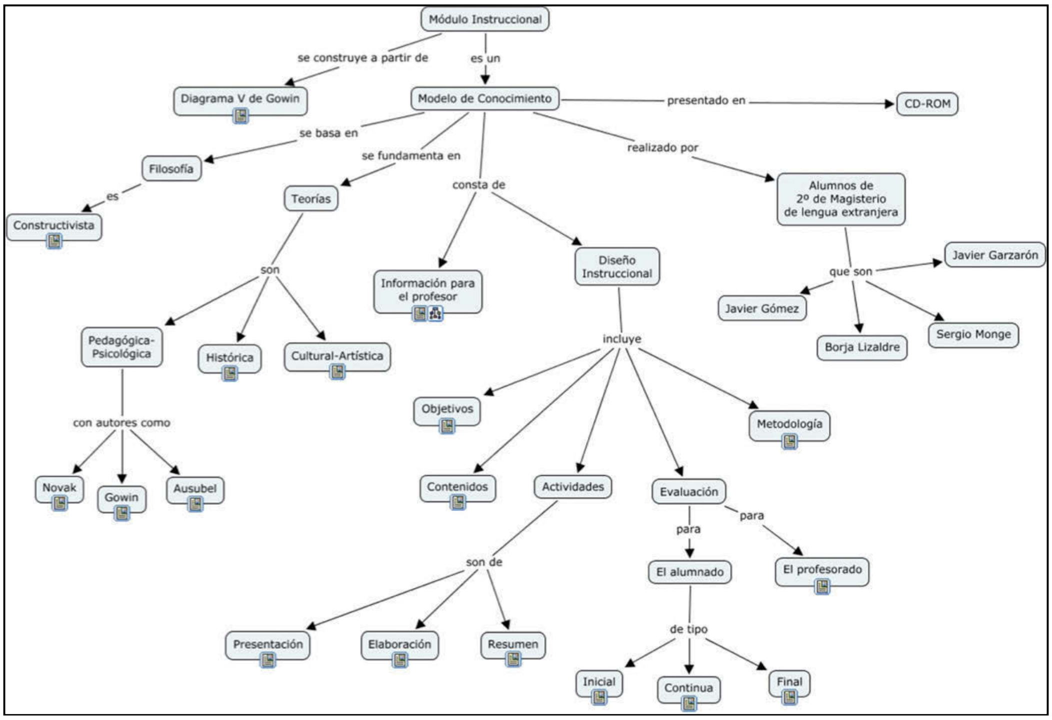

Figure 11. Example of an IM developed by a group of TNS students.

3.2 Inquiry results

A survey was done to students in order to check if they felt happy with the structure of the subject and with the theoretical and practical contents or if they had any suggestions for its improvement. The poll was filled by students who attended class in a particular day (30 students). It posed with 6 closed questions and 1 open question. Among the 6 closed questions, 22 students (73,4%) considered the presentation of the TNS course through CmapTools was practical; 21 students (70%) considered this format allowed them understand and study the contents of the three blocks of the course, better, comparing to the more conventional teaching style; 27 students (90%), confirmed there was consistency in teaching the subject in the same format that it was intended they learnt, for its application in their future as teachers of Primary Education; only 2 people (6,7%) wanted to study the theoretical contents in a more traditional teaching style; 25 students (83,3%) confirmed that they would use what they learned in the course to make their teaching materials in the future; and 22 students (73,3%), considered the teaching of the subject as a KM, enabled them to achieve the necessary skills for becoming Science Teachers in Primary Education.

The open question, was related to the quality of the teaching, being the question, “What do you suggest in order to improve the teaching of the TNS subject?”. In this case, 6 students (20%) did not answer, whereas 24 students (80%) did it. Overall they alluded to aspects related to the theoretical content of the course, to the practice, to the necessary time, the dynamism and to instructional tools. With regard to the theoretical content, 8 students (26,7%) considered important to clarify the specific contents to study for the exam or written test; 3 students (9%) wanted to explain more deeply some scientific concepts and 8 students (2,7%) suggested less theoretical content; in the case of the practice, 5 students (16,5%) wanted more practical sessions, with emphasis on the design of practical experiments held in the laboratory (3 students, 10,6%) and the possibility of taking a trip to a Natural Science Museum or to a Natural Park (8 students, 2,7%); 4 students (13,3%) indicated they missed more dynamism in class; with respect to the recommended instructional tools, 2 students (6,7%) answered CmapTools should not be the axis of the subject, and preferred to make the IM, without using the software; finally and regarding the timing, 3 students (9%) agreed they needed more time for the explanations of scientific and practical contents.

4 Discussion

TNS is a compulsory subject of the educational program of the Degree of Primary Education Teacher (DPET) at the Public University of Navarra. So far, it was considered a difficult subject by students, because they assume Science and Humanities cannot get along together. Our approach as University teachers, has been to try to use the same instructional tools we teach our students, in order to build our subject, so that DPET students, see the coherence and start imitating, by creating their own teaching material, understanding better the practicality and functionality provided by the use of instructional tools. The subject is structured in 15 theoretical sessions and 15 practical ones, in order to combine what learnt with what done to teach. It becomes a teaching –learning (university)-teaching-learning (school) chain (didactic sequence) and we have to test our proposal (using instructional tools for preparing teaching material and for teaching) is useful for our students. For that, we designed an inquiry which showed in general, students were more concerned about the theoretical contents for the exam or written test than for learning or acquiring knowledge. This fact, gives as a clue for transforming the assessment and change students' perspective, so that they rather want to know and get to a domain of knowledge than to only pass an exam. Although, perhaps this is just a question of maturity.

The software applied, CmapTools, allows teachers to generate the conditions facilitating students to transform the information in useful, substantive and transparent knowledge, to be integrated in their knowledge structure and in their long-term memory. Students play an active role, not only learning about the product and selecting the information, but through the process itself (metacognition), leaving behind the previous behaviorist-positivist model which favored mechanical-rote learning and advocating a new model, cognitive-constructivist allowing a meaningful and long life learning as well as promoting critical thinking. During the teaching-learning process University teachers try to make PET students concerned of the power they will have for shaping the society of the future when educating children. The constructivist philosophy illuminates the path to follow and authors, such as Novak, Ausubel and Gowin, provide us with the tools to create knowledge, remove misconceptions and associate emotions and learning. It has been a very grateful experience to adequate the subject to what it is being taught and we will take in consideration all the suggestions made by students for improving the subject with more practical training in laboratory, maybe visiting some Natural Science Museum or the Planetarium or taking a trip to a Nature Park in the surroundings. However, results have been very positive because students consider TNS provides them with the competences for becoming Primary Education teachers, they appreciate the consistency of being taught in the way they will have to teach in the near future, they seem motivated and committed to improving the quality of education and adapting their teaching material to the time and a great percentage of students confirm they will apply KM in their future teaching activities.

Alluding to the Ecology of Practices (Bronfrenbrenner, 1979; Kemmis & Mutton, 2009; Pérez de Villarreal, 2016), we consider TNS subject is a dynamic living being who needs to be fed and to continue raising and interacting, and any changes made, are always for the evolution of the creature and its adaptation to the environment.

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TEACHING, LEARNING, AND ASSESSMENT INTEGRATION IN ELECTRONICS ON THE CONCEPT MAP BASIS

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Abstract. The paper describes the concept mapping technology employment in Electronics education. It is shown that the concept maps represent a suitable tool to support instructors in promoting students' comprehension of the studying material and in improving their conceptual understanding. An original educational thesaurus is introduced that displays the learners what they have acquired from the lessons. It supports them in making connections between new and prior concepts and reinforces knowledge integration by such a promotion. The developed concept maps are regarded as a valuable instrument of many assessment procedures. They represent learners' knowledge providing informative and reflective feedbacks tailored to learners' personal styles and habits.

1 Introduction

Today, many organisations seek better ways to enhance their educational methodologies that, according to the UNESCO publications, should provide novel arrangements for creation, defining, and application teaching, learning and assessment resources and processes with their common integration. The major aim is to design high-quality educational process, which motivates students to learn both the skills directly related to their professions and the additional knowledge domains valuable in the specific working environments.

Knowing how and what students learn is important for judging the appropriateness of learning objectives and deciding instruction improvement. Like in other disciplines, students begin their training in Electronics from the basic concepts with an introductory Electronics and Semiconductor Engineering course that introduces such elementary parts like semiconductors, electronic devices, amplifiers, filters, and digital components. Next, the students continue learning with the Power Electronics course where they study power converters, including their features, connections, major calculations, and development issues. Educators supply the graduates with knowledge about the general concepts in the field and enhance their understanding of ties among other topics for their future studies. At that, both the learners and the teachers face many problems in these.

Instructors regularly expect learners to link for themselves the concepts they learn in Electronics and the objects they study across other disciplines in their curriculum. Doing so, educators bear in mind the new educational technologies that enable trainee to acquire great amounts of studying materials. Often, they supply the students with additional printed and the virtual data. The printed resources involve textbooks, tutorial aids and lecture notes, exercises, labs explanations, quizzes, examination problems, etc. The virtual group covers the e-books, web manuals, software, and databases along with learning portals, webinars, and social networks. The regular learners and educators' exchange upon the partner agreements and international programmes increase the students' activity as well. In addition to the traditional university resources, the learning guides from the partners and enterprises together with the open Web resources are now accessible for learning. Most of them were explained and described deeply in Raud (2012).

The educators are often disappointed when the trainees have failed to connect expected topics: they disregard the situation that wide knowledge proliferation often results in such a serious problem as an information stages (Chen, Kinshuk & Chen, 2006). Doing work without guidance, the students find fragmentary and scrappy information being unable to make complete and systematic knowledge in the field. For students, it is difficult to express a comprehensive map of Electrical Engineering, Electronics, Power Electronics, Physics, and similar domains due the diversity of the concepts in the appropriate curricula. It is not easy to percept the practice and theory behind the studied topics and their interconnections. As the learners find these courses difficult for understanding, their motivation in studying and success of learning are brought down. In (Tokdemir & Cagiltau, 2010), the similar reasons were explained regarding other engineering disciplines.

Many studies focus on the new approaches that enhance the acquisition of large information volumes. In particular, an effective "curriculum container system" has been proposed in (Wu et al., 2005), which five-level composition includes the curriculum, unit, task, episode, and element levels. The educator's activity is restricted in this case by the curricula "aggregates" hence any time when a teacher decides to modify the educational trajectory the curriculum has to be changed. Another popular instrument designed by these authors is a "conceptual graph" for knowledge representation, which more influences on the syllabi volume rather than on the curriculum structure.

The study of (Kavitha, Vijaya & Saraswathi, 2012) applies such knowledge acquisition objects like headings, titles, overviews, previews, typographical cues, summaries, number signs, recall sentences, summary indicators, and indicators of importance that produce larger information storage. Research of (Roy, 2008) has shown that proper arrangement of learning volume and context successfully increases the amount of knowledge that students can acquire as well as their overall comprehension. Particularly, graphical representation of studying volume can reduce the information overload and students' disorientation.

As for now, the concept mapping represents one of the most powerful graphical tools for the knowledge acquisition (Shieh & Yang, 2014; Rudraraju et al., 2014). As follows from (Guastello, Beasley & Sinatra, 2000; Jain et al., 2014; Thanasis et al., 2014), the concept maps scaffold students in understanding the novel topics by mapping the links among new and previously studied domains. In the same way as with other disciplines, Electronics can be discussed as a knowledge domain, which collects some finite volume of concepts and links among these concepts. A representation of such a collection suitable for knowledge reuse and sharing is known as ontology (Gruber, 1993). Commonly instructors apply ontology made by domain experts in the corresponding field of science to prepare their course syllabus in a way that mitigates knowledge overload and information disorientation. Besides, teachers also use ontology to design their tutorial aids and to prepare some learning tools to guide their students (Chandrasekaran, Josephson & Benjamins, 1999). To display ontologies and to transfer them from instructors to trainees, three types of systems are used, namely, mathematical models, descriptive models, and graphical ones (Satzinger, Jackson & Burd, 2000). The concept maps (Novak & Gowin, 1984) as a graphical representation of knowledge comprised of concepts with their relationships successfully demonstrate how to use prior knowledge as a framework for learning the new knowledge. From the constructivist viewpoint, a learner acquires the new knowledge by integrating the new concepts with the existing ones (Ausebel, 1963). This stresses the importance of prior knowledge in learning the novel concepts. In (Raud, Vodovozov & Lehtla, 2010; Raud & Vodovozov, 2011) concept mapping was represented as a first stage in ontology development and used flexibly to display a knowledge topology for meaningful learning together with the educational thesauri.

Basing on the concept mapping methodology, this paper reports about the enhancement and refining of a teaching strategy and technique of Electronics education. The first part of work focuses on the concept map employment in Electronics domain where the authors have developed the set of concept maps and associated graphical network resources. Next, the paper explains how to define the required concepts using multiple knowledge resources, design the requested concept maps, and arrange the learning objects referred to these concepts. In the further sections, it is shown how the concept maps assist learners in understanding the Electronics knowledge domain and the concept cross-linking. The proposed concept maps are employed as an instrument for improving understanding of learned areas both before and after the lessons. Finally, the paper demonstrates how a particular concept status can affect different learning goals thus giving the students some adaptive guidance for the course appreciation.

2 Educational Thesaurus

An effective descriptive model in the form of educational thesauri (ET) has been developed by the authors of this paper as the first step of the Electronics ontology design (Raud, 2012). In contrast to other well-known thesauri, ET was intended primarily for educational purposes. It has been taken into account that every discipline studies the concepts in a specific context and gives them distinctive meanings that deviate from the meaning of the same words in other contexts and in everyday language. A properly organised course ET is described by a direct acyclic graph whereas a speciality thesaurus is represented by the forest of such graphs. Basing on this target, the ET topology estimation and the definition were given in (Raud & Vodovozov, 2011).

To build ET, the key concepts in Electronics were first chosen as candidates to be included to ET (Raud & Vodovozov, 2012). Such concepts proposed by different authors are not always consistent as they often describe the same concepts using similar terms but not exactly the same ones. Therefore, these terms were primarily classified by instructors into appropriate groups to reduce their total number. Next, our purpose was to summarize the large datasets by removing any redundancy in the data for finding the key concepts. At last, an evaluation of "relation strength" was decided.

The ET created to store these grouped terms has become a suitable tool from this viewpoint (Raud, Vodovozov & Lehtla, 2012). Every ET entry represents an article explaining a separate concept, including its term and definition. A concept which meaning is described by a particular entry was called as a defined concept whereas earlier introduced entries used to explain a defined concept were called as parents. Ten lines below represent a very short fragment of an educational thesaurus for the Power Electronics course (Raud & Vodovozov, 2011) where the following concepts are defined:

1. **power electronic converter (PEC) –** *electronic converter* that converts energy in a power electronic system;
2. **dc/dc converter − PEC** converting *dc* to *dc* of another level;
3. **load** − object connected to the **PEC** output;
4. **supply** − *power* line feeding the PEC;
5. **boosting** − generation of the **load** *voltage* which level is higher than the **supply** *voltage* has;
6. **booster − PEC** with **boosting** possibilities;
7. **boost converter** – **booster**;
8. **switching dc converter − dc/dc converter** built on a *switching* principle of operation;
9. **buck converter − switching dc converter** the output *voltage* of which is less than the input *voltage*;
10. **buck-boost converter – buck converter** combined with a **boost converter**.

Here, the concept terms are given with the bold typeface and an italic font is used for the terms incoming from prior disciplines, such as Electronics and Electrical Engineering. The defined concept terms occupy the left side of each line whereas the definitions are to the right. In Table 1, a fragment of the ordered concept table is presented.

i	Term	Parent 1	Parent 2
1	PEC		
2	load	PEC	
3	supply	PEC	
4	boosting	load	supply
5	booster	PEC	
6	boost converter	booster	
7	dc/dc converter	PEC	
8	switching dc converter	dc/dc converter	
9	buck converter	switching dc converter	
10	buck-boost converter	buck converter	boost converter

Table 1: Fragment of the concept table in Power Electronics

These ranked thesauri now accompany many electronic documents of the courses related to learning Electronics in Tallinn University of Technology. With the help of interactive hyperlinks, an educational thesaurus clarifies and explains the concepts through other learning materials including lectures and practical aids. This interactive hierarchically structured dictionary explains currently about 1000 concepts in the Power Electronics. Every ET entry has a semantic (meaningful) connection with the earlier given definitions. An alphabetically ordered thesaurus index is arranged as the database table. In addition, a thematic index exists which guides the learner throughout the discipline, from the root concept to the leaves of the knowledge tree.

3 Concept Maps as a Teacher Tool

Following (Villalon & Calvo, 2008), the above approach applied to teaching Electronics represents accurate information about the knowledge domains studied. As any map is a graphical representation of a more or less ET fragment, during the map development we selected the set of concepts and the linking words to arrange the basic propositions in the field. These concepts were accomplished in a proper topology at which concepts that are more general appear higher in the map, and concepts that are more specific occupy lower levels. Concepts within the same level of generalization were located on the common topological levels. Therefore, the outcome of our concept mapping has comprised of concepts, relationships, and a topology.

In (Chen, Kinshuk & Chen, 2006), the procedure of knowledge transfer has been shared between four main steps:

- information retrieval,
- concept extraction,
- search for the key concepts,
- evaluation of “relation strength”.

Accordantly this organisation, before constructing a concept map for a domain, every teacher in our team has distinguished between content covered through lecturing and content provided through labs, exercises, and other studies. Additionally, such informational resources as textbooks, scientific and popular books, and websites supply the students with required data also. To arrange successful concept extraction, the instructors collected their terms in an educational thesaurus where they summarised large datasets and removed data redundancy. During this process, the evaluation of concept “relation strength” has been decided. In the simplest case, a linear map topology without loops and with minimal concept linking could be proposed. However, as far as many concepts have complex interconnection and, on the contrary, some concepts have no links with other concepts, the teachers minimized such decoupling using the peer-to-peer communication.

We have found that a focus question of the particular lesson should be interpreted by no more than 25 concepts. This demand affects concept mapping with minimal redundancy and minimal loss of information. Therefore, simplicity is the first important instructor’s requirement. If a concept set is too large, several concept maps can be used. In the same way, summaries were created for a chapter and for a part of the studied domain.

Concept maps of different instructors are subjective, because every concept map represents the author’s individual knowledge and skills. In an educational context, a teacher wants to infer the student’s understanding and perspective on a topic. The educator also wants that terminology used by the student would enable assessment of the outcomes, so the concept maps should be represented by different resources in the same way, i.e. using the same words. This requirement affects concept mapping in two ways:

- the concepts and relations are to be extracted from a common basic ET;
- the concept hierarchy has reflect the importance of the concepts in the particular domain.

Based on the above regulations, the major problem in the concept map design was to discriminate the most meaningful concepts from the less important ones. Thus, the first step taken by the instructors was to consider which concepts are most essential, those that the student should not obviate. The second step of a concept map creation was to join the concepts in a meaningful information structure. In this way, a specific network was designed consisting of concept nodes (points, vertices) and links (arcs, edges) which provides such relations among concepts as “is a”, “related to”, or “part of”. Besides these two steps, another quality details have appeal the map designer’s interest, such as segregating of the major concepts from the rest using different highlighting (colours, fonts, shapes, etc.), representative figures, icons, and connecting to external websites, applications, or the concept maps from other institutions. The maps developed also include cross-links between concepts of different domains that show how one knowledge domain is related to another domain.

Figure 1 represents a fragment of the thesaurus designed for Power Electronics in the CMAP Tools environment. All the maps developed include the nodes with the key concepts enclosed in rounded rectangles. Each concept has the individual definition label. In the topology, the concepts are represented in a hierarchical fashion with the most general concepts at the left side and the less general concepts arranged hierarchically to the right. Concepts of the equal generalization level are located on the same topological level. The hierarchy of a particular sub-domain is also defined on the context in which its information is being applied or considered. The cross-links are shown in the map as the named shortcuts. As a result, the outcome of the concept maps comprises concepts, relationships and a topology.

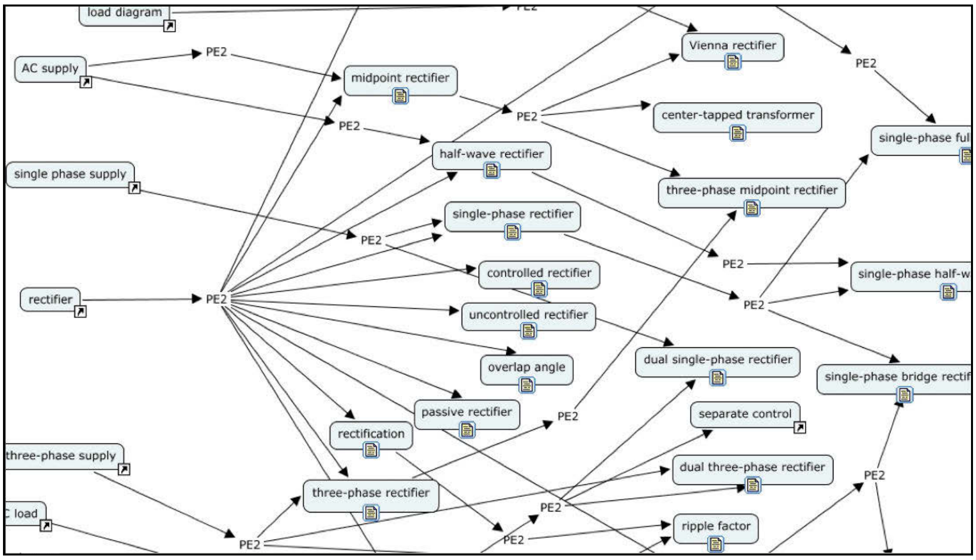

Figure 1. Fragment of concept map in Power Electronics.

The concept maps developed have become a suitable instrument supporting the teachers in promoting students' comprehension of the learning material and improving their understanding of new material.

4 Concept Maps as a Student Tool

The aim of concept mapping for learners is to interpret learners' personal understanding and their possibilities to draw individual examples against the existing theoretical and practical tasks. As the concept maps display graphically some of ET fragments being a flexible tool to focus attention on important aspects of knowing, they help to explore what students actually learn and how they do it.

Our mapping experience demonstrates what learners see as important concepts and how they relate these concepts. The results of mapping have implications for clarifying the learning objectives, refining instructional strategies, identifying appropriate assessment tools, and understanding how the learning objectives are being realized by students.

In the designed system, the concept maps are used for learning using one of the two ways:

- students are asked to develop their own concept maps following a topic in the focus
- students are asked to analyse some preliminarily designed concept maps built by instructors or other learners

Both approaches look to be effective tools in improvement of the learning outcomes. These maps engage in a process of reflection, collecting and selecting appropriate knowledge. We agree with (Bozhko & Heinrich, 2011) that the concept maps allow students

- to develop a flexible structure for self-directed learning;
- to manage large amounts of information in the knowledge base which they build in the learning process;
- to track personal progress in various areas and aspects;
- to share their maps with others for feedback or evaluation;
- to facilitate setting up the personal learning goals.

When concept maps are designed in the classroom, we follow the recommendations of (Chang & Tsai, 2005) and restrict usually the mapping time by 5 to 20 minutes. On the contrary, if mapping specifies the homework, learners will have a lot of information from numerous sources, such as books, Internet, and other digital media libraries. The contents of these sources can be useful to appreciate the course or to simplify knowledge understanding. Otherwise, it is not a trivial job for students to organize and identify the main thematic topics. Therefore, the students force multiple learning objects and make notes in their concept maps to personalize learning and to re-enforce it for increasing skills and promising the knowledge sharing.

The hierarchical nature of the concept map allows organizing concepts from the high abstract level to more specific layers. This property can be used by students for managing and structuring data. Following the qualitative analysis techniques, our students create their own relations for the concepts that later form their personal concept maps. The learners can also be provided with a map structure predefined by teachers. Moving through the study program, they can learn to understand these concepts and recognize the valuable examples of their work in the learning process. During this work, the students generate definitions for the concepts by describing them from their own viewpoints.

It was disclosed many different approaches that students apply when representing the similar sets of concepts. Basing on a review of the students' maps, the following commonly occurring situations have been identified:

- students often insert superfluous nodes between related concepts;
- the same nodes of the map hierarchy are often moved to different positions in a hierarchical tree;
- one and the same node is frequently represented by one student as the major concept while another considers it as the subsidiary concept;
- a particular node in one map may match many nodes in the other one in the maps built by different students;
- students commonly provide different links between the same nodes, hence reflecting different understanding of these relations.

It was found as well that concept mapping without training is very problematic for students that are usually unable to structure and integrate the information in a proper way. Following (Roy, 2008; Marshall & Madhusudan, 2004), to produce a favourable outcome we consider training as a key factor. When concept maps can be easy explained to learners, we arranged training and map construction at the same time. The students were not asking to generate maps on the computer. During the training, they prepared the small hand-written maps suitable for easy reading. We agree with (Peters, 2005) that concept mapping can be introduced to the classroom with relative ease. From five to 15 minutes of the concept map training may be easily fitted into nearly any schedule. Consequently, we ranged the time to grade maps from three to 10 minutes, which appeared not more time consuming than multiple-choice quizzes or short essays.

As a result, our experience has shown how the concept mapping improves students' understanding of the material acquired from the class and how they make connections between the class and prior concepts. Mapping reinforces knowledge integration providing the learners with an activity, which promotes such integration. As far as the students enhance their understanding, they find more evidence in their knowledge area. Thanks to described dynamic nature of learning, the individual concept maps might never be complete (Bozhko & Heinrich, 2011). Concept mapping promote also many discussions, particularly if they are placed onto the screen and students see them. Finally, the maps help to find where and when the students need additional instruction.

5 Concept Maps as an Assessment Tool

A further strength of concept maps is their important role in assessment (Gouli et al., 2005). Concept maps are a valuable tool of assessment procedures because they evidently represent learners' knowledge through multiple feedbacks tailored to students' personal characteristics and requests.

It is difficult to assess what every student knows in a broad subject area. An important feature of concept maps is that they tend to be unique for each student. It is well known that human minds are highly different, especially, when they come to interpretations such as quality or completeness. As it has been reported in (Calafate, Cano & Manzoni, 2009), different people would construct different concept maps, even if they answer the same question and share the same level of expertise. Such uniqueness prevents an instructor from doing a quick evaluation since the estimated object is not right or wrong, but rather more complex, elaborate, and precise in direct relation to the students' understanding of the addressed domain. Therefore, the assessment process is prone to be complex, time-consuming and, in general, includes a strong degree of subjectivism, which should be mitigated (Stockwella, Smithb & Wilesa, 2009). The subjectivity appears when the teachers ask the concept maps they constructed for the same knowledge expressed in their lecture or textbooks.

To meet the challenge, it was found in (Roy, 2008) how to assess student's possibility in extracting quantitative and qualitative information about the studied material. In (Calafate, Cano & Manzoni, 2009), partitioning of the assessment process has been proposed using the steps followed for their creating as well as objective metrics that assign every step. Some authors scored the maps along several dimensions, including their comprehensiveness, the number of details, and the complexity of the links.

We have found that the concept maps as an assessment tool require consideration of as minimum two issues:

- how the maps are designed;
- how they are interpreted.

Effectiveness of these two issues have resulted in two approaches we used to compare the learner's maps with the expert's ones (Turns et al., 2000; Gouli et al., 2005). At the former, student-generated concepts approach, the maps collect the concepts and links a student identifies relatively to an evaluated domain. Every student constructs his map either directly or indirectly, with the help of an instructor who implements the learner's idea. The strength of this method is that emphasis is done on the understanding how a particular student appreciates a separate domain. Individual differences of student's understanding can be captured here. However, as the concept maps resulting from this method can be large, complicated, and difficult to interpret, it is usually problematic to provide a final judgment about a student's knowledge. In the second method, called an externally generated concepts approach, the assessment represents a quantitative comparison between two concept maps − the student's and the teacher's maps. Following this result, a map is interpreted by determining similarity between these two maps. The referent map might be constructed by a tutor based on his/her own knowledge or a map constructed to represent key knowledge in a textbook. The measure of similarity between the two maps displays the level of the student's knowledge.

The maps submitted by the students are usually quite diverse (Turns et al., 2000). A couple of such examples from our practice are shown in Figure 2. Three groups of the second-course bachelor students (about 60) were asked to build the concept map of the rectifiers studied in a series of lectures, exercises, and labs. The focus problem of mapping was to demonstrate the learners' ability to systematize their knowledge obtained from different sources, such as class lessons, own experience, textbooks and tutorials, Internet, peer-to-peer communications, etc. The examples show that the learners demonstrate different understanding of the concept relations, ranking, linking, and nodding. Some of learners resemble the maps that have been created during the classroom work. Such maps generally receive rather low scores on the comprehensiveness, detailing level, and complexity dimensions. To receive higher grade, the map should represent a large number of concepts, their cross-links, and hierarchy layers thus showing that the student can differentiate the elements of the domain. The volume of meaningful links contributes to the score significantly.

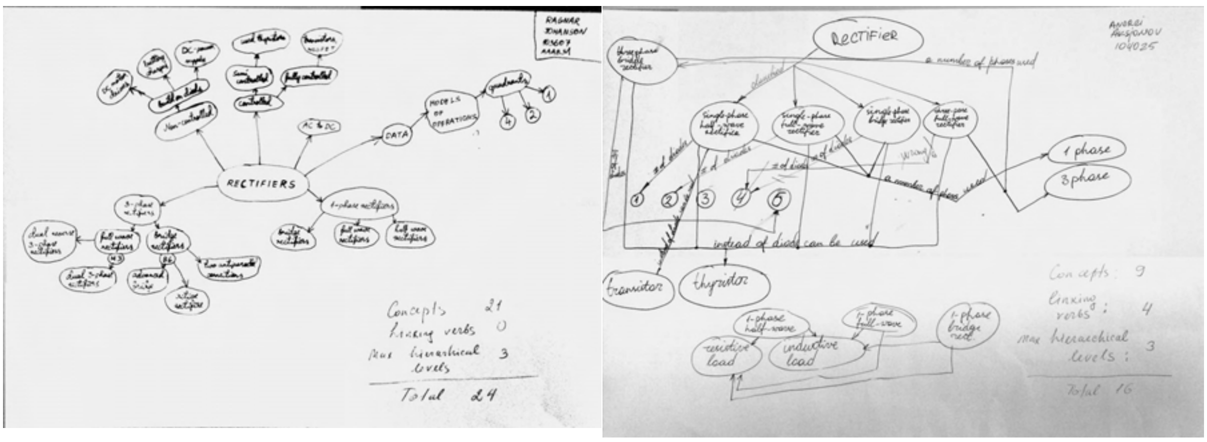

Figure 2. Students' concept maps.

The map interpretation usually covers both the quantitative scoring and the qualitative judgments on the appropriateness of the assessed model. In our assessment procedure, the final grade involves scoring the student's maps along such dimensions as the number of concepts, links, hierarchy levels, and examples. These scoring data stem from the concept mapping goals representing such features as breadth, depth, and connectivity. In addition to the scoring along these dimensions, the maps are commonly inspected for the number of invalid positions as well as the absence of major concepts and relations. During the assessment, every dimension is scored on a scale from zero to five.

The distribution of scores obtained in our experimentations argues that most of the students can reach rather high ratings. This suggests that by the end of the course, most of the students have acquired the concepts that they learned. For the volume of the acquired details, most of students have received the middle-level scores. This proves differences in the students' possibility to realise detailed concept description. The scoring distribution for concept connectivity has the greatest variation thus showing the difference between the students who learned carefully and those who were less successful in systematic learning.

6 Summary

It is shown that both the educators and the students have difficulty in development and interpreting the concept maps in Electronics as well as in establishing relationships between the concepts and entities. Being rather complex and time-consuming task, concept mapping requires considerable efforts in determination the major concepts and relations. The proposed study opens the useful ways for both the educators and the students in concept mapping application. The recommendations are presented how to get better results in Electronics comprehension and assessment. It is shown also that thanks to its process-oriented nature, concept mapping enlarges opportunities in success in all learning processes. Of course, the concept maps cannot be the only instrument because they represent a part of the full educational process. Usually they require much time to interpret and can remain ambiguous. They do not guarantee that the students are able to apply the concepts in design or other authentic engineering activities.

7 Acknowledgement

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THE EFFECT OF CONCEPT MAPPING ON EFL STUDENTS' MEANINGFUL LEARNING OF ENGLISH READING COMPREHENSION

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Abstract. This study investigates the effect of concept mapping on EFL students' meaningful learning of English reading comprehension. 61 high school female students were randomly assigned to experimental and control group in Karaj and their academic achievement by quasi-experimental design with pre-test and post-test was studied. The research instrument was a teacher-made academic achievement test, in which the high levels of cognitive questions (analysis, synthesis, and evaluation) were used to evaluate the meaningful learning of English reading comprehension. The data were analyzed with t test, and the results showed that concept mapping strategy has a positive effect on English academic achievement and meaningful reading comprehension in students.

1. Introduction

Learning and academic achievement have always been of great interest for educational systems around the world. Bruner (1966), the theorist of discovery learning, believes that the educational theories should address the question of how to learn better and more. Accordingly, educational psychologists have proposed some learning strategies for a better learning; these learning strategies teach learning methods and accurate studying.

Park (1995) defines learning strategies as the ''mental activities that people use when they study to help themselves acquire, organize, or remember incoming knowledge more efficiently''. There are a number of learning strategies that can help students to become more sophisticated learners, and thus better able to learn and to achieve in the classroom over the long run. These strategies include recognizing important information, note taking, summarizing and meaningful learning (Pressley, 1982; Weinstein, 1988).

One of new strategies based on Ausubel's meaningful learning is of concept mapping. Concept map was proposed to confront the non-meaningful learning and as a result of Novak and his colleagues research to find a way to offer the concept perception. According to Ausubel (1968), meaningful learning means integrating new subjects to previously learnt material into one's cognitive structure. Cognitive structure involves an organized set of principles, concepts and information that the individual has learned and is a hypothetical pyramid in which more general concepts and subjects are placed at the higher places and more detailed subjects are placed in the lower level of the mentioned pyramid. If the learner relates the new subjects to the ones learnt before in his/her cognitive structure, the learning is regarded as meaningful; however, if the new information is acquired through repeating, practice and without relating it with the previous subjects, his/her learning is regarded as rote learning. Therefore, students need encouragement to learn meaningfully. The use of concept maps can be a powerful aid to achieve meaningful learning (Novak, 1991)

Although concept maps have been demonstrated to be a powerful instructional tool in different educational areas, most studies have been focused on scientific and technical areas (Rueda, 2009), less attention has been given to theoretical areas such as literature, history and teaching second language. A lot of Iranian students have problem in English reading comprehension. Not only the high school students have this problem, but university students also do. In spite of the fact that students start Studying English from sixth grade and continue to the last year of high school, they use the meaningful learning techniques a little and the results of institutes exams, final exams, and national entrance exam show that the English level of students is low and the students are weak in applying English language.

Although researches support concept mapping as an effective method on meaningful learning, not enough steps have been taken to apply this teaching-learning method in classrooms. This study is an attempt to investigate the effect of concept mapping on English improvement and reading comprehension meaningful learning of EFL students.

2. Concept Map

Concept maps are tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts or propositions, (indicated by a connecting line and linking word) between two concepts. Linking words on the line specify the relationship between the two concepts. Propositions contain two or more concepts connected with other words to form a meaningful statement (Novak, 2008). Concept maps can be applied as a learning strategy (Novak, 2004, Quinn et al, 2004), teaching strategy (Marangos & Alley, 2007) and assessment tool (Novak, 2008, Williams, 2004). Concept maps are applied in teaching and learning in different methods, one of the major methods of applying concept map is making the maps by the learners. In the process of concept mapping, the learner links the new material to familiar ones in his cognitive structure and shows it in terms of a graphic design by combining, linking and hierarchically organizing the concepts; this process contributes to meaningful learning.

A concept map is a powerful tool in facilitating meaningful learning (Novak & Cañas, 2006, Cañas et al, 2003, Irvine, 1995) and due to presenting a pattern and a framework to create and organize the knowledge, that not only permit utilization of the knowledge in new contexts, but also the retention of the knowledge for long periods of time (Novak & Wandersee, 1991). Concept mapping as a learning strategy changes the learning direction from a teacher-based to student-based by activating the learner in the learning process; therefore, causes an improvement in academic abilities and proficiency (Laight, 2004, Peterson and Snyder, 1998) and also increasing the students' marks (Marangos, 2000). Research has proved the effectiveness of concept mapping on meaningful learning (Novak, 2003, Trifone, 2006). Retention and retrieval (Hall and, O'Donnell 1996), perception and understanding (Kimber et al, 2007), academic achievement (Brussow and Wilkinson, 2007, Hauser et al, 2006), English comprehension and learning second language (Dias, 2010, Conlon, 2008, Liu et al, 2010, Marriott & Torres, 2008, Vakilifard & Armand, 2006, Ojima, 2006, Bahr & Dansereau, 2001, Chularut and Debakar, 2004, Koumy and Salam, 1999). Individuals, whose native language is not English, require techniques to learn better, retain longer and apply the language in new situations. Furthermore, the teachers are seeking educational methods that help the students to be activated in learning process and their achievement. Among effective factors on learning and teaching language, teaching-learning strategies have important role in learning in which concept mapping is the focus of attention.

3. Research Background

Since 1976, that Novak proposed concept mapping, concept maps have been used widely in different fields. The studies have shown the significant effect of concept mapping on meaningful learning (Horton et al. 1993, Novak & Cañas, 2006, Novak, 2010). Most of the conducted studies have focused on first language and few researchers studied second language learning.

Moreira & Moreira (2011) used concept maps as an instructional tool to foster the construction of knowledge in Foreign Language Education classes. The findings of the study showed that using concept map can help students build up self-confidence on their ability to use newly acquired/learned concepts in new contexts. Liu & Chen (2010) investigated the Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension. The results suggested that concept-mapping strategy not only causes reading comprehension improvement, but also improves other reading strategies using.

Dias (2010) used concept maps for enhancing Bachelor students' English reading comprehension as L2 in Brazil. The findings showed that the construction of meaning by the creation of concept maps can be an effective reading strategy in English as an L2. Moreover, the students not only learnt how to create map by using the software CmapTools (Cañas *et al.*, 2004), but they also could empower in the development of their autonomy concerning ways to organize knowledge acquired from texts. Lee and Cho (2010) in a study on Korean students titled "Concept mapping strategy to facilitate foreign language writing: a Korean application'' concluded that concept mapping was beneficial in improving Korean students writing skill in general, and in improving the organization, language use, and vocabulary in writing in particular.

In a study by Chularut & DeBacker (2004), the influence of concept mapping on achievement, self-regulation, and self-efficacy in students of English as a second language were investigated. The subjects of the study were college and high school students who were studying English in private English centers. The findings of the study showed that a group of students who used concept mapping, achieved higher scores in their self-efficacy and self-regulation in comparison to control group.

Armand & Vakilifard (2006) studied the effects of 'concept mapping' on second language learners' comprehension of informative text. The results of this study indicate that the subjects of the experimental group obtain higher scores on the comprehension questions than those of the control group. Ojima (2006) conducted a case study of three Japanese ESL writers in Japan on the effect of concept mapping as pre-task planning. The results showed that concept mapping improved writing skills of English learners as a second language.

It should be mentioned that most academic researchers have studied concept-mapping strategy as an academic project and haven't used it in real formal classrooms. In the current study, the researcher investigated the effects of concept mapping on students reading comprehension abilities in official classroom.

4. Research Goals and Hypothesis

The purpose of this study was to investigate the effectiveness of concept mapping on English improvement and reading comprehension meaningful learning of EFL students. Research hypothesis include:
H1: Concept mapping effects on students' academic achievement of English language.
H2: Concept mapping effects on students' meaningful learning of English reading comprehension

5. Methodology

5.1 Participants

Sixty-one female students in third grade of high school in Karaj city who were studying during the school year 2013-2014 were selected through purposive sampling and were randomly assigned in experimental and control groups. Their field of study was literature and human science. Official restrictions and not intending to interrupt current educational schedule were the reasons why we applied purposive sampling.

5.2 Instructional materials

English language book 3, which is a third grade high school textbook, was selected as the instructional material. This book is reading base one, 65% of which is composed of reading, comprehension and vocabulary. The book is composed of 6 lessons, each including a 6 to 7 paragraph - reading, vocabulary, language function, grammar and pronunciation. The focus of the research was reading comprehension.

For each lesson the researcher and teacher, using the software Cm tools designed a concept map. A linguist expert and four experts of the English teaching group approved the maps. The maps were of hierarchical type in which major and more general concepts were placed in higher locations and special and more detailed concepts were placed in lower place. These maps were regarded as the standard maps (see Figure 1).

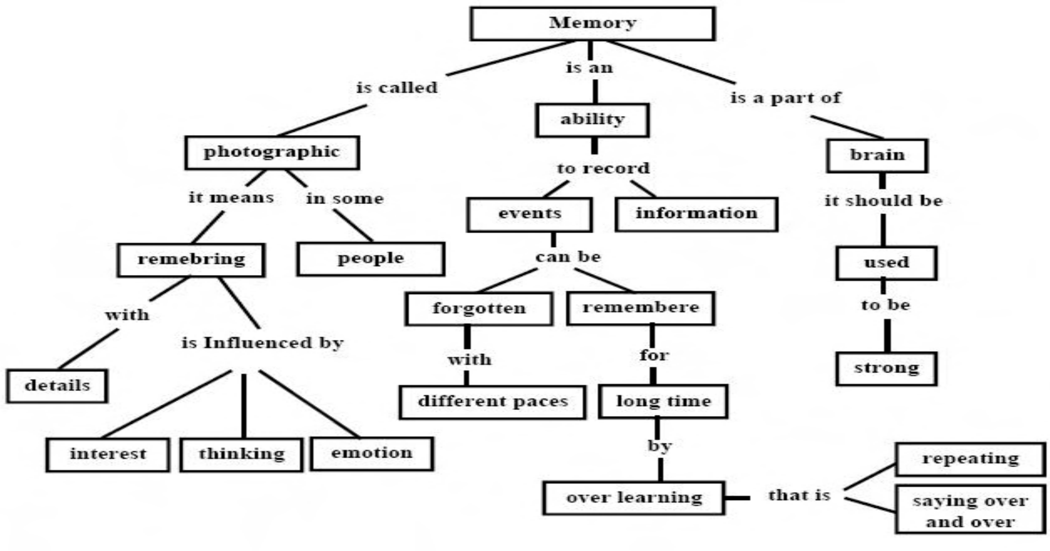

Figure 1. Example of criterion concept map constructed by researcher and teacher.

5.3 Measurement tool

Teacher-made academic achievement and criterion-referenced test were used to measure learners' academic achievement and meaningful learning. The test questions were designed based on Bloom's classification of cognitive domain (1956) in levels of knowledge, understanding, application, analyzing, composition and evaluation. The questions were multiple choice, short-answer, match, and concept map design and incomplete concept mapping template. Concept map and analyzing, synthesis and evaluation level questions were applied to assess the meaningful learning. The following steps were taken to propose the academic achievement test:

1. Preparation the instructional objectives for each lesson
2. Designing table of contents for each part of the book: In this stage, the proportion of each part of the content, reading, vocabulary, language function, grammar and pronunciation was specified based on the allocated time and volume and then the proportion of each part in the number of the related questions was determined (10 parts, 40 questions).
3. Designing two dimensional table of specification of objective and content: The table included two entries; the row of the table showed sections of each lesson, the columns showed the levels of Bloom's cognitive classification and the table cells showed the proportion of each part of the test's total score. In order to certify content validity of the academic achievement test, the questions were designed based on objective -content table and after final designing of the questions; the test was approved by five experts in English language experts. The test reliability was calculated with Kuder-Richardson20 which was 0. 93.
4. Evaluation of the Questions: Five experts in English language educational group studied the test questions and some corrections were done. Furthermore, the test was primarily performed for the students of two classes (40 students), coefficients of difficulty and discrimination were calculated and the weak questions were revised and corrected.

5.4 Research design and procedures

The methodology is a quasi-experimental design with a pre-test and a post-test. Concept mapping as a learning strategy was regarded as the independent variable; meaningful learning and academic achievement were regarded as the dependent variable and were assessed through an academic achievement test. The experimental group was instructed by concept map strategy and the control group was instructed by current methods of teaching, asking and answering. To control the effective factors on the students in control and experimental group from high school grade, field of study, previous year average, gender and age the school of studying and teachers have the same conditions. The research was performed in 4 steps:

1. Preparation Stage: In this stage, activities such as instructing the teacher, preparing the lesson plan, preparing the concept maps, preparing academic achievement test and selecting the sample were performed.
2. Pre-test: Before exposing the students to any instruction, a teacher made test was administered to the selected subjects to be sure of their homogeneity.
3. Training stage: Instruction by concept map method was performed through 12 (60-minute) sessions, every two weeks during a school year. In the first session, the students became familiar with concept map, its features, how to make it and some related examples. In second and third sessions, first, the teacher with the cooperation of students read the text and explained complex words. Then, students were asked to specify main and related ideas of the text. The teacher wrote main and related concepts on the board and asked students to make a concept map individually. In these sessions, teacher helped students in concept mapping. In the following sessions they were assigned to create the concept map as homework, regarding the following stages:
   - Selecting the major concept of the text (using a question on the topic of the text)
   - Listing some text concepts and arranging them from more general to detailed
   - Specifying the relationship of the concepts
   - Linking the concepts to each other by directed and non-directed lines
   - Adding a word or statement to the line to present the relationship between the concepts
   - Hierarchically organizing the concept mapping

In the following sessions, the students made the maps. The process of the other sessions included collecting students' maps, assessing the previous learning based on the concept mapping (two or three students presented their maps), returning the previous maps through oral and written feedback and instructing the new lesson. A point was allocated to each concept map as a part of class activity (see Figure 2). The control group students were instructed to the same lesson through the traditional method of teaching (e.g., giving lectures for teaching vocabulary and grammar, reading the text).

4. Assessment Stage (post-test): At this stage, the students of two groups participated in the final exam for measuring their achievements, their meaningful learning of reading comprehension of the book texts; the allocated time was 90 minutes.

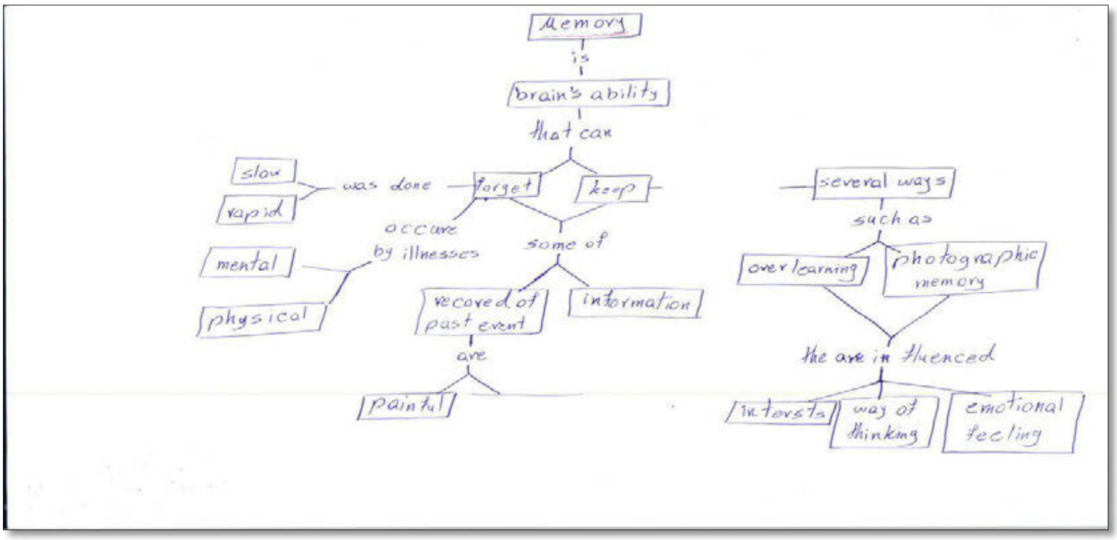

Figure 2. Example of concept map constructed by a student.

6. Results

Mean, standard deviation and ***t-test*** were used to statistically analyze the data and research hypothesis. To discuss the differences between two groups' English post-test, first the differences between two groups in pre-test were compared with a t-test. The results of t- test to compare the difference between two groups, have been shown in table 1. The results show that there is no significant difference between them (0.05<p)

Group	N	Mean	Std. Deviation	t	Df	Sig.
Experimental	31	7.74	2.29	1.55	57	0.124
Control	28	6.89	1.83			

Table 1. The results of t-test to compare the control and experimental groups in the Pre-test Scores.

Regarding the first hypothesis of the research, "Concept mapping effects on students' academic achievement of English language", the results of the t-test to compare the two groups, are presented in table 2. Because the level of significance of the table (0.026) is less that 0.05 Alfa, the research hypothesis regarding the effect of concept mapping on academic achievement of English language is approved. Since the mean of the experimental group, which was exposed to independent variable, is 13.19 and the mean of the control group, which was not exposed to this variable, is 11.31, this increase can be attributed to the impact of the independent variable.

Group	N	Mean	Std. Deviation	t	Df	Sig.
Experimental	32	13.19	3.5	2.28	59	0.026
Control	29	11.31	2.9			

Table 2. The results of t-test to compare the control and experimental groups in language learning achievement.

Regarding the second hypothesis, "concept mapping effects on students' meaningful learning of English reading comprehension", the results of t-test to compare the two groups, are presented in table 3. Regarding the fact that the level of significance in the table (0.0001) is less than 0.05 Alfa (p<0.05), the research hypothesis regarding the effect of concept mapping on meaningful learning of English reading comprehension is approved.

Since the mean of experimental group, which was exposed to the independent variable, was 13.53 and the mean of the control group, which was not exposed to this variable, was 6.95, this increase of the mean can be attributed to the impact of the independent variable.

Group	N	Mean	Std. Deviation	t	Df	Sig.
Experimental	32	13.53	4.36	7.875	41.549	0.0001
Control	29	6.95	1.7			

Table 3. The results of t-test to compare the control and experimental groups in meaningful learning of reading comprehension.

7. Discussion

Applying concept map as a learning strategy was effective improvement of academic achievement and meaningful learning in language learning. The students in the experimental group who were taught by concept map strategy and created it got better scores in academic achievement test in comparison with the control group who were taught by traditional (lecture) method. Since students participated actively in the construction of knowledge and were encouraged to present their perception in the text in terms of concept mapping, their learning was improved. The results of this research are in accordance with that of (Dias, 2010, Vakilifard & Armand, 2006, Chularut & Debakar, 2004, Brussow & Wilkinson, 2007, Trifone, 2006, Mesrabadi *et al*, 2008).

Regarding the impact of concept mapping on meaningful learning, the results showed that the scores of students in the experimental group have significant differences in higher cognitive levels (analysis, synthesis, evaluation). This shows the impact of concept mapping in facilitating the meaningful learning. Meaningful learning means that the learner can organize the information and assimilate them in his/her knowledge framework. Creating the concept mapping requires understanding, recognizing the main concepts, linking the concepts with previous ones, establishing new bonds and organizing the concepts. This process causes meaningful learning and applying higher-level cognitive functions. The results of the research are in accordance with the findings of Moreira, & Moreira, 2011, Liu et al, 2010, Conlon, 2008, Ojima, 2006, Erdem *et al*, 2009, Novak, 2003, Novak & Cañas, 2006.

During concept mapping in reading comprehension, the learners learned and used learning strategies like recognizing important information, summarizing, reviewing, expanding and organizing the concepts and text structures and presenting the concepts in the form of showing. Also finding out the topic and the concepts of the text causes the concentration of the students and reviewing the text for several times. Therefore, it causes the transformation of the information to long-term memory, retaining and recalling the materials. Creating the concept map helps learners to retrieve old information already learned and combine them with new knowledge to learn more new vocabulary and concepts and also their use in new situations. On the other hand, the process of creating concept map requires the activating of learner in learning process and interaction with instructional materials. Activating the learner in the process of learning causes the improvement of academic learning and increasing the students' scores (Laight, 2004, Peterson. & Snyder,1998, Marangos, 2000)

Creating the concept map is a feedback for both the teacher and students to recognize the knowledge and understand the subject and point out the learning deficiencies. Furthermore, assessing the students' learning by the map and considering a score for drawing the concept map was an external motivation for the students and they recognized the impact of the mapping on deeper understanding of the text and on their ability to better retain and recall the vocabularies.

This research showed the impact of concept mapping on deep and meaningful learning of the English language, achieving higher cognitive levels, activation of learner in the learning process; it is suggested that learners apply the concept map to deepen and strengthen their learning and teachers improve students' learning and academic achievement using concept map as a teaching strategy, learning task and assessment tool.

8. Limitations of the Study

As all other interventional studies, this study had some limitations. Due to some Ministry of Education's strict rules, the researcher could only use a small sample size. The sample was a nonrandom and affected the generalization of the study. Second, the study took place in an official classroom in the school with only two hours of English study in a week. Creating the concept map of a course is difficult and time consuming and needs lots of hard work. Because both the students and teacher had to finish the book on time based on the Ministry of Education's schedule, therefore they paid less attention to concept mapping activities.

9. Summary

This quasi-experimental study aimed at the effects of concept mapping on students' meaningful learning of English reading comprehension. The experimental group received concept mapping as a reading strategy in teaching. While the control group taught with traditional method. Teacher made achievement tests were given to the students to evaluate their meaningful learning and achievements. Test marks showed that those of experimental group significantly did better comparing to control group. It is hoped that the findings of this study will help improve reading comprehension in EFL classes and help teachers to promote their knowledge and find different ways of teaching reading strategies. Further studies need to be done to approve the findings of this study due to some before mentioned study limitations.

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THE TEACHERS' VOICE: FORMING A THEORETICAL FRAMEWORK COMBINING A PREKINDERGARTEN STEM CURRICULUM AND A LEARNING CURRICULUM

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Abstract: The purpose of this paper is to describe the use of the results of the photovoice evaluation of a robotics, programming, and problem solving curriculum to form a theoretical framework for the curriculum designed for 4- to 5-year-old children. Concept maps of the photovoice evaluation indicated that the teachers thought the most important themes of the 3-month project were when children were engaged, worked independently of the teachers and cooperatively with classmates, were persistent, learned academic knowledge and skills, and developed problem solving skills when using KIBO. A comparison of the project evaluation plan and the teachers' academics theme found that the evaluation plan predominantly assessed the teachers' statements about academics. Researchers reviewed the research bases of the remaining themes and used concept mapping to combine the new research bases with the academic knowledge and skills theme to form a theoretical framework for the project. The framework combined the robotics, programming, and problem solving curriculum and a learning curriculum emphasizing the development of children's productive dispositions towards learning. The addition of the learning curriculum reinforces that the key to successful implementation of this STEM initiative was the classroom teachers' integration of the RAPP lessons into the established prekindergarten curriculum within the morning center rotations. With the addition of the teachers' voice we can add a vibrant description of the learning curriculum rather than the short statement, *a positive, authentic classroom environment* that we now use. The discussion presents possible next steps and uses of the new theoretical framework for the robotics, programming, and problem solving curriculum.

1 Introduction

The purpose of this paper is to describe the formation of a theoretical framework that incorporates the results of the photovoice evaluation of the Robotics and Programming for Prekindergarten (RAPP) pilot project. RAPP is a series of lessons designed to introduce 4- to 5-year-old children to robotics, programming, and problem solving. Using photovoice enabled the researchers to hear the teachers' voice concerning the importance of their students' participation in RAPP activities. We first describe RAPP and the elements of the evaluation plan. The lessons provided activities designed to teach children about engineers, problem solving, and programing within the context of a positive, authentic classroom environment. The focus of this paper is limited to the five important themes resulting from the photovoice evaluation. Gaining greater insight from these results required that we dig deeper into the research bases of the four non-academic themes to establish a theoretical framework that incorporates all of the importance of RAPP identified in the photovoice evaluation. But first, we briefly describe the RAPP project, the participants, the complete extent of the evaluations, and the approach used to establish a theoretical framework incorporating the photovoice results and the relevance of that framework to the evaluation of future RAPP implementations.

2 Robotics, Programming, Problem Solving, and Evaluation

The purpose of RAPP was to develop and implement innovative STEM lessons for children in prekindergarten classrooms. Promoting science in prekindergarten prepares children for later science learning and is a developmentally appropriate endeavor that capitalizes on young children's natural curiosity (Bers, 2008). However, children's natural curiosity and intuitive sense of technology and engineering are rarely nurtured in typical prekindergarten classrooms. Moreover, the introduction of engineering and programming coupled with the use of robots helps children learn about abstract mathematics and science concepts in concrete ways and assists the development of children's technological fluency (Rogers & Portsmore, 2004). Children as young as 4-years old can understand programming rules and create commands for robots to follow. Moreover, programming directly relates to foundational concepts including patterns, sequencing, modularity, and cause-and-effect.

The RAPP research team selected KIBO, a robot developed at DevTech, Tufts University (Boston, Massachusetts, USA) and commercially available at KinderLab. KIBO is an interactive robot, designed specifically for 4- to 7-year olds, that uses programming blocks with bar codes and descriptions of their functions—icons for prereaders and words for readers. KIBO has an embedded bar code scanner that requires no screen interface. During the 3-month pilot project, three RAPP researchers designed and implemented 12 robotics and programming lessons and one concept-map-assisted review of the lessons in the participating classrooms. (See McLemore & Wehry, 2016 for more complete RAPP details and results from other evaluations.) The remainder of this section provides information about the RAPP participants and evaluations.

2.1 *Prekindergarten and Preschool Participating Teachers*

The RAPP pilot project involved developing, iteratively refining, and evaluating RAPP using a partnership between a university research team and six experienced prekindergarten teachers from three childcare centers located in an American urban area. All three childcare centers enrolled children from low-income families. In this area, the typical non-public-school-based childcare center teacher has no more than an Associate's Degree. During February 2016, the teachers attended a 3-hour professional development workshop designed to teach about KIBO and programming. Each attending teacher received a KIBO kit to use in her classroom.

2.2 *Evaluation*

The evaluation of RAPP includes data collected from the researchers, the participating teachers, and the children in the classes of the six teachers working directly with the researchers. A fuller description of the evaluation is included in Table 1.

2.3 *Photovoice*

Photovoice (photo voicing our individual and collective experience) is a highly flexible research methodology with roots in health education and community advocacy. The use of photovoice provides visual images as evidence and promotes participation as a means of sharing knowledge and experiences (Evans-Agnew & Rosemberg, 2016; Wang & Burris, 1997). As adapted for RAPP, photovoice is a process by which childcare center teachers with access to KIBO kits could identify, represent, and enhance their experiences through photographs of children learning by interacting with KIBO. Ten teachers, all female, participated in the photovoice evaluation: six prekindergarten teachers working with the researchers and four using KIBO without the researchers (including two working with children slightly younger than prekindergarten children).

As part of the photovoice evaluation, the RAPP research team asked teachers with KIBO to email two photographs per week (during 12 selected weeks) that they thought were most representative of importance relative to KIBO use in their classrooms. During the second full week in April after the children had completed six lessons, and after the third week of May when the children had completed all RAPP lessons including a concept-map-assisted review of all lessons, the researchers conducted discussions with each teacher using the pictures from the photograph submissions. The first step in the process, at both discussion times, involved asking the teacher to narrow the field by selecting the three most important pictures and then to discuss with her researcher why the selected pictures were the most important.

2.4 *Using Concept Mapping to Organize and Present Knowledge*

Coffey *et al* (2003) suggested that knowledge mapping, one purpose for using concept maps, is useful in recording both explicit and implicit knowledge. The implicit knowledge is knowledge that is held internally and, thus, not easily communicated. In using photovoice, researchers used photographs to elicit both types of knowledge from participants and concept mapping to organize their collective thinking. RAPP researchers also used concept mapping to form the framework for the photovoice results. Concept mapping is an efficient and effective way to organize and present knowledge. In fact, visual presentation of knowledge is often more concise and easily understood than text (Coffey, 2015).

2.5 *Results*

The steps in forming the summary of the researcher/teacher discussions included the summary of the discussions, the concept maps formed from the teachers' summaries, and a table of the concept map's propositions. The researcher who summarized the discussions concept mapped all ten transcripts in an effort to synchronize teachers' language across transcripts. For consistency, the first level of all concept maps was *Children* and the second level was *KIBO & Parts*. The listing of propositions function in the CmapTools helped identify similar language. The five themes that emerged from the teachers' conversations are shown in Figure 1. In order of importance to the teachers, the children:

Source	Measure	Frequency	Assesses
Researchers	R1. Lesson Rubrics (R1LR)	12 times	Immediate measure of learning objectives. For example, the number of children who could identify the *forward* and *shake* blocks and could identify the *begin* and *end* blocks at the end of lesson 4.
	R2. Reflection Notes (R2LN)	12 times	Used to rewrite curriculum as needed
Teachers	T1. Qualtrix Survey (T1QS)	Twice 3rd week in March & 2nd week in May (6 teachers)	Use of KIBO Student engagement when using KIBO Student interactions with KIBO affordances Students' happiness when doing RAPP activities Open-ended questions about the teachers' implementation of KIBO
	T2. Photovoice (T2PV)	Twice 2nd full week in April & 2nd week in May (10 teachers)	Results provided five themes about RAPP that the teachers thought were most important.
Students Children in the six classes of the teachers working with the researchers.	C1. Happy Bowls (C1HBa,b,c, d)	Twice 3rd week in March & 2nd week in May	Using 3-pt Likert scale (*not happy*, *happy*, & *very happy*) by placing a happy face bean bag in a small, medium, or large bowl to respond. a. How happy are you when you learn about engineers and what they do? b. How happy are you when you scan a program using KIBO? c. How happy are you when you see KIBO act out your program? d. How happy are you when you draw and write in your Engineering Journal?
	C2. KinderLab Challenges (C2KLa,b,c)	Twice 3rd week in March & 2nd week in May	Three challenges modified from KinderLab a. Assessing knowledge that a program must have a beginning and end. b. Assessing knowledge that other programming blocks go between the beginning and end blocks. c. A story presenting a problem for KIBO that the students must make and scan a program to solve.
	3. Child Interviews (C3CI)	Twice 2nd week in March & 2nd week in May (mostly in pairs)	Resulting concept maps and scores provided data used to evaluate increases in knowledge about problem solving and KIBO.
	4. BBCS-3:R scores (C4BBCS)	Twice Fall & spring of the school year	Scores from 12 RAPP children included in a random sample of children receiving state-subsidized childcare. Of particular interest were the gains in the Position/Direction and Time/Sequence scales.

Note. Text in parentheses represent acronyms that are used in the concept map presented in Figure 2. BBCS-3:R is the *Bracken Basic Concept Scale-Third Edition: Receptive*

Table 1: The evaluation plan for the spring 2016 RAPP implementation.

- Exhibit engagement,
- Work independently of the teacher and cooperatively with classmates,
- Persist when working with KIBO,
- Learn academic knowledge and skills, and
- Develop problem solving skills.

The photovoice evaluation provided valuable insight about RAPP because the list of important aspects of KIBO use was entirely generated by the teachers' voice. For the most part, their voice stems from their KIBO implementation, without the presence of the researchers, as they integrated RAPP into their morning instruction. The information provided from these entirely open-ended discussions is essential to further efforts to use robotics with prekindergarten children because it is bottom-up statements of importance from the teachers rather than top-down statements of importance and promise from researchers and policy makers.

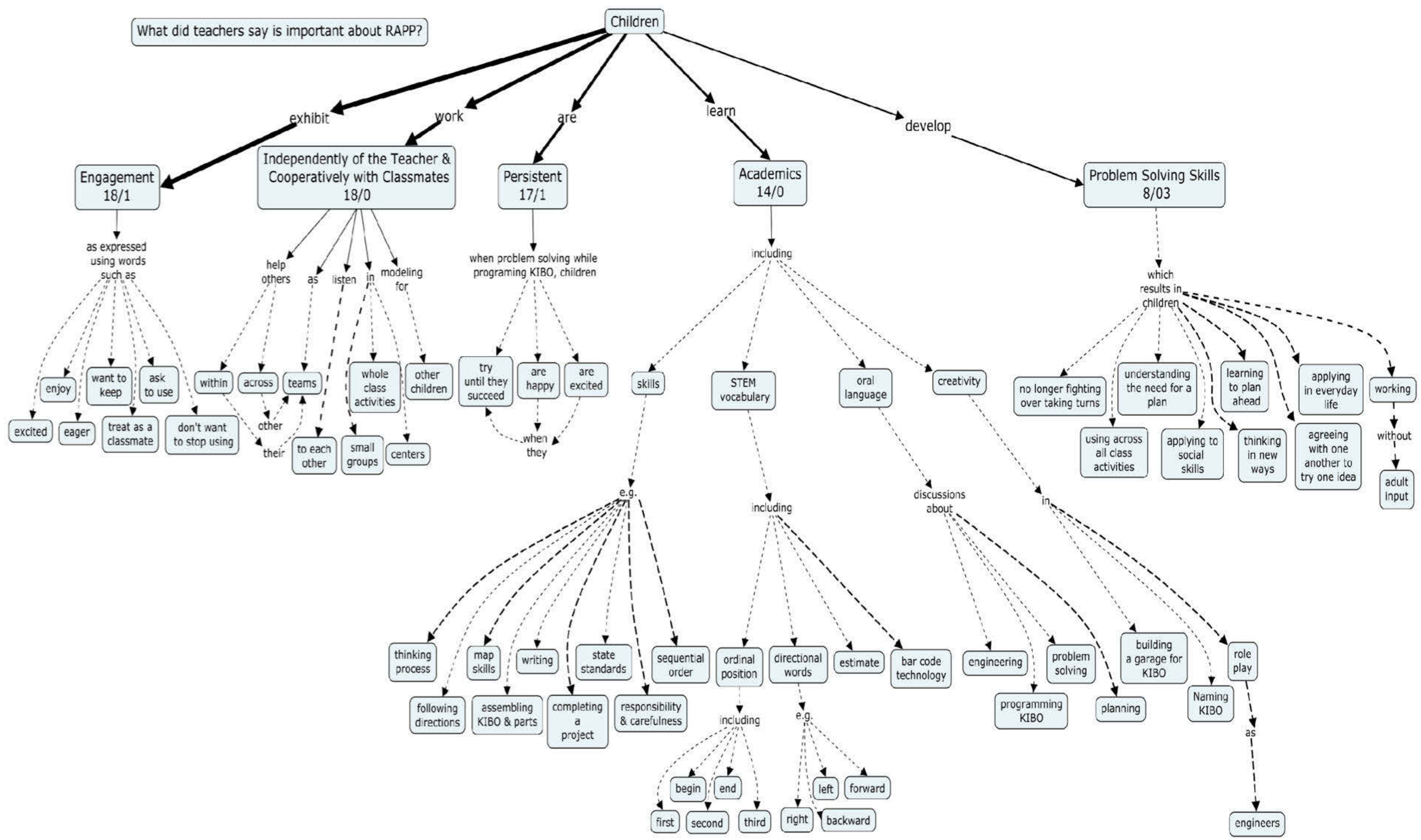

Figure 1: Concept map detailing what teachers most frequently indicated was most important to them in using KIBO. The concept most frequently mentioned, engagement, is on the left side of the map with the heaviest line. The first number under the concept indicates the number of teachers who explicitly mentioned the concept during both discussions, and the second number represents the number of teachers who implicitly acknowledged the concept during either discussion. Words that the teachers used during the first discussions are connected using a dotted line, and those mentioned only in the second discussion are connected using a bolded, dashed line.

The elements of the evaluation plan somewhat addressed children's engagement from both the teachers' and children's perspectives using Likert-type scales. However, the main focus was the academic content of the lessons. Thus, children being engaged, working independently of the teachers and cooperatively with their classmates, being persistent, and learning problem solving with transfers to other domains were not addressed.

3 Photovoice Results, the RAPP Evaluation, and the Theoretical Framework

The first step in making fuller sense of the photovoice findings is to match the academics branch of the concept map in Figure 1 to the evaluation elements detailed in Table 1 to make sure we did evaluate the academics that the teachers described as important. The final step is then to form the theoretical framework that incorporates all five of the teachers' themes.

3.1 Mapping RAPP Assessments to Photovoice Themes

The RAPP assessment plan includes qualitative data collected from the implementing researchers, childcare center teachers, and the children. These data include the researchers' lesson rubrics and reflections, teachers' Qualtrix survey results, and child happy bowl surveys. Quantitative data include children's KinderLab challenges; interviews, concept mapped and scored; and BBCS-3: R scores (Bracken, 2006). The evaluation plan directly addressed child engagement at the basic level using the Qualtrix teacher survey and the children's happy bowl assessment and indirectly through the researchers' lesson rubrics and reflection notes. The theme that one would expect the evaluation plan to address is the *Academics* theme, which 70% of the teachers mentioned at either one or both of the discussions. Figure 2 shows the relationship between the Academics theme and the RAPP evaluation.

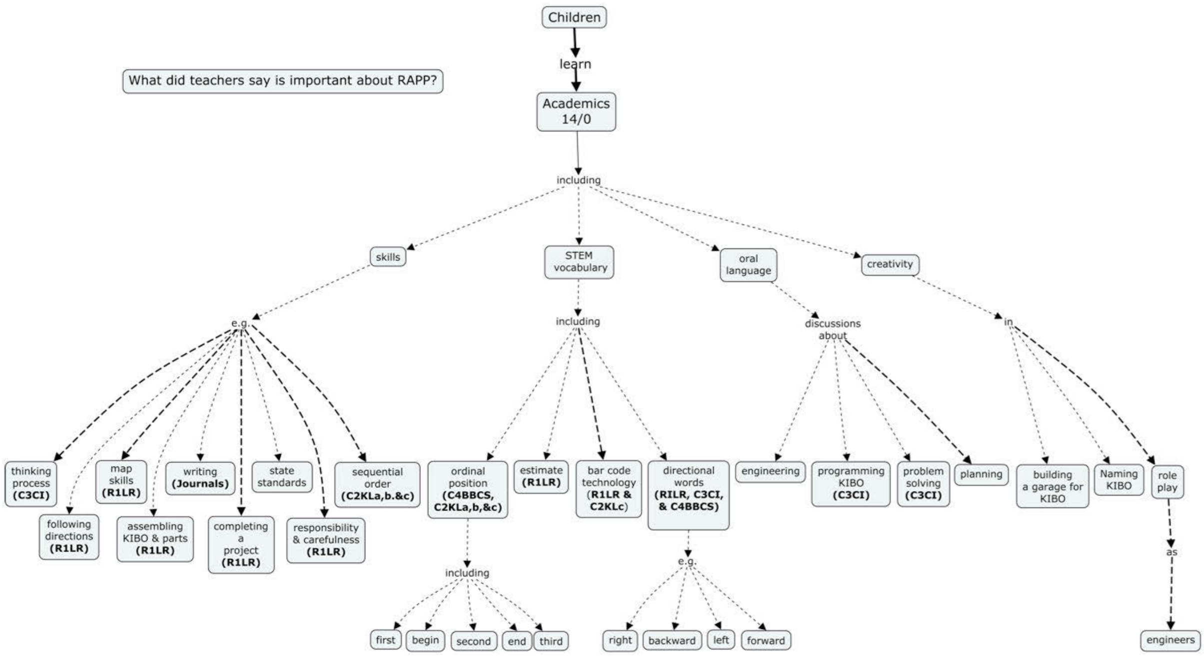

Figure 2: Concept mapping of the photovoice Academic theme and the RAPP evaluations. Words that the teachers used during the first discussions are connected using a dotted line, and those mentioned only in the second discussion are connected using a bolded, dashed line. Bolded text underneath the concept labels represent the part of the RAPP evaluation mapped. *Journals*, an assessment of writing, is the children's Engineering Design Journal which are not part of the RAPP assessment plan. The RAPP children were part of a larger project developed to encourage the development of young children's writing. RAPP participants, at the beginning of RAPP, changed the emphasis of their writing to engineering in their journals. At this time, those journals have not been evaluated, but when the writing project data are complete, the journal writing will be available as part of the RAPP evaluation elements.

As can be seen in Figure 2, most of the academic skills, STEM vocabulary, and oral language concept map branches link to some part of the evaluation plan. R1LR assessments can form an explicit or implicit link. For, example, 'map skills' were part of one of the later lessons in which the researchers provided a flip chart paper map (red tape marking a path with at least one right or left turn) with several locations (e. g., McDonalds, a gas station, and a playground), and a beginning point. The challenge was to program a trip for KIBO to the various locations. The challenge required multiple tasks including the ability to follow direction in understanding the challenge, understanding the representation on the map, completing the project through solving the identified problem by forming a program with the correct sequence of block with debugging as needed. Thus, children who met the lesson objectives demonstrated a broad group of academic skills and knowledge.

In addition to these themes and assessments, statements from two of the prekindergarten teachers are very important to the purpose of this paper. We removed the words of the researcher for brevity and what is presented is in a narrative form rather than a discussion.

Researcher: Can you tell me anything about the impact that working with KIBO this year has had on student learning?

> First Discussion Early in the project, the children learned that engineers solve problems and to make sure that the class was using the '*Think*' [emphasis added] part of the Solve-It 4, I had them design a program without using the blocks but rather just the vocabulary words. (No help from the teacher.) The object was to make sure the children *thought the program out* [emphasis added] first. Then they created the program using the blocks. … The children learned to *think—the thought process* [emphasis added] and began transferring the process to everyday life problems. If they can't do something one way, then they *think* [emphasis added] of another.
>
> Second Discussion It's given them an opportunity to learn how to work independently and self-strategize—not always having somebody tell them what to do. They can plan for themselves. It's really helped in my classroom—KIBO and building partnerships with classmates as in working together, making a plan, following it, using someone else's suggestions and not always being a leader but learning how to work together in positive ways. The children are using the KIBO terminology throughout the day and they're always singing the little songs, and it reflects through different activities whether it's with LEGOs, or we're getting ready to do an illustration dictation. They are thinking ahead, and then they are planning and implementing. It has really shown up not only with KIBO but throughout other areas in the classroom … KIBO provides them a new opportunity. I don't think that many of them have ever been able to just take a piece of equipment like that and handle it so freely without a parent or adult saying, "oh no, that's wrong." They're able to work hands-on and create something on their own without so much direction from an adult.
>
> What KIBO has brought into my classroom is the integration of factors we hadn't really counted on—like using the vocabulary from KIBO lessons on engineering, problem solving, and programming. When the children start to argue on the playground, they use the strategies of problem solving from the KIBO lessons. So that has been very helpful in our regular curriculum.

The first teacher speaks to the issue of the children's thinking, *learning how to think*, as being very important to her. For many decades, educators have been criticized for producing graduates who know a lot of facts but cannot think. It was a pleasant surprise to hear this prekindergarten teacher express how important it is to her that the young children she teaches learn 'how to think'. The second teacher speaks of the children's unique opportunity to independently explore (without interference from adults) and learn with KIBO. These children frequently transfer KIBO learning, including problem solving skills, to other classroom experiences.

3.2 Theoretical Framework for the Photovoice Themes and the Robotics and Programming Project

The photovoice evaluation, and more specifically, the statements made by the two teachers whose narratives are provided above, led the RAPP research team to use the photovoice results to form a theoretical framework incorporating the teachers' voice. The framework would position the photovoice results in a broader knowledge structure than that provided by solely using the STEM, robotics, and early childhood education research bases.

The first step in the process was to search the existing research concerning engagement, persistence, working independently and cooperatively, and transfer of knowledge across domains of learning. In combining the old framework and the new findings, we realized that what the teachers voiced is a 'learning curriculum' in which students learn how to learn. The engaging robotics, programming, and problem solving academic curriculum occurs simultaneously with the learning curriculum which is centered on the goal of learners acquiring and continually developing productive dispositions towards learning—or children approaching learning *ready, willing, and able to learn*.

We placed the concepts from the learning curriculum and the academic parts of the RAPP curriculum in a concept mapping 'parking lot' and organized the concepts into the theoretical framework depicted in Figure 3. As can be seen, using robots and problem solving from the academic curriculum encourage the development of students' productive dispositions.

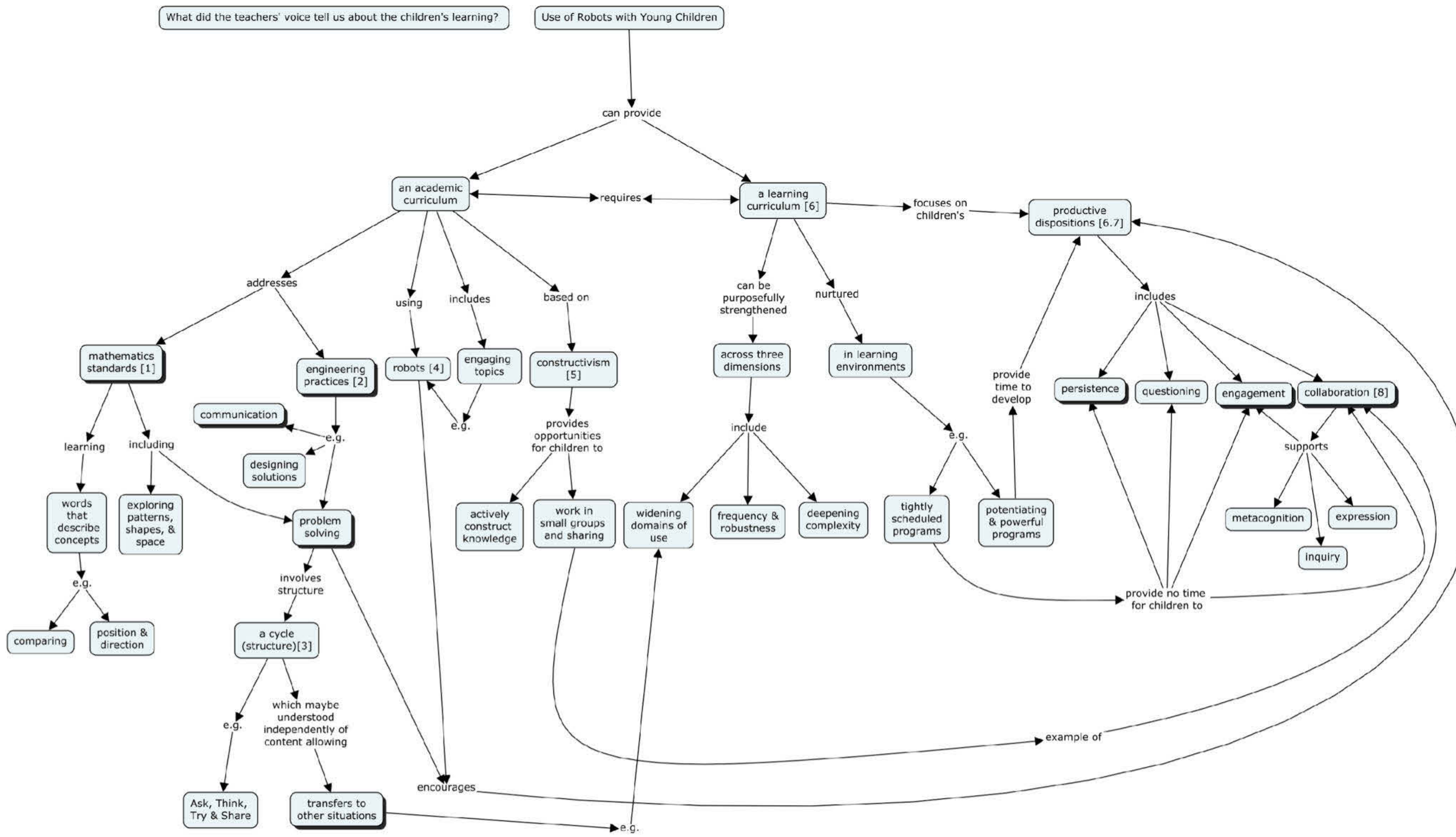

Figure 3: The theoretical framework for the five themes identified from the teachers' voice. The concepts with the dark shadows represent concepts directly linked to the concept map in Figure 1. The number in square brackets represent citations. [1] NCTM (2000), pp 73-143; [2] the NGSS Framework: Appendix 12 (2013); [3] Day & Goldstone (2012); [4] Toh et al. (2016); [5] Wheatley (1991); [6] Claxon & Carr (2009); [7] Sarama & Clements (2009); and [8] Finn & Zimmer (2012).

4 Discussion

While the RAPP researchers accomplished teaching the basic skills, the key to successful implementation of this STEM initiative was the classroom teachers' integration of the RAPP lessons into the established prekindergarten curriculum within the morning center rotations. The fact that the teachers chose to incorporate RAPP during the morning instruction is important because those are the hours funded by the state which emphasized literacy in the statutes creating the program. As soon as the program was created state prekindergarten standards were created. The state officers did not include engineering, robotics, or programming in the state standards. Given the perceived standards-based pressures, the RAPP teachers still acknowledged the benefits of implementing the RAPP lessons—most likely resulting from the tangible results of the learning curriculum—to exchange some of the existing lessons for the engineering, robotics, and programming lessons in their tightly scripted morning schedules.

The assessments, presented in Table 1, worked as intended and support each other to form a fairly complete evaluation of the RAPP lessons. RAPP researchers actually acknowledged the learning curriculum by using the phrase, *within the context of a positive, authentic classroom environment*, in the introduction to this paper and other publications. The photovoice results provided assessment of the learning curriculum as well as the academic curriculum. We certainly plan to modify the Qualtrix survey items and the happy bowl questions to include more items relative to the photovoice results. Also, we will continue to use photovoice as part of evaluations of future RAPP implementations as the research team adds more lessons and expands this 3-month curriculum to at least a 6-month curriculum. If future results obtained from different teachers in new settings produce similar results than the presented results and framework have greater validity.

We have no doubt that we will use this expanded theoretical framework in grant writing and discussions with policy makers. The photovoice results are very encouraging and the resulting framework provides us with a way to talk about the results within the research community and positions the project in a broader knowledge structure than that provided by solely using the STEM, robotics, and early childhood education research bases.

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Resumen. En este trabajo se analiza la manera en que un grupo de docentes de Nivel Medio Superior, en México, aprendió a construir y utilizar los mapas conceptuales en un curso-taller, aprendiendo las herramientas necesarias para la realización de los mismos y de esa manera poder replicarlos en sus respectivas materias a sus alumnos. Los docentes, miembros de una escuela privada incorporada a la Universidad Nacional Autónoma de México (UNAM) realizaron el curso-taller a lo largo de un mes completo, aprendiendo estrategias para realizar mapas conceptuales significativos (basándose, en parte, al aparato referencial de Ausubel) y aprendiendo a construir mapas conceptuales en base al aparato referencial de teoría lógico-filosófica del autor del presente artículo, así como en la teoría del mapa conceptual de Manuel Francisco Aguilar Tamayo. El presente artículo muestra algunos rasgos descriptivos, algunos explicativos y algunos generadores de cambio (en base a los modelos de cambio conceptual de Hashweh) sobre las conclusiones y reacciones del grupo de docentes que trabajó en el curso-taller con el objetivo de que al aprender a generar una lectura del mapa conceptual idónea, enseñasen en menos tiempo diferentes temas y se logre de manera más efectiva dentro de cada materia hacer aprendizajes significativos con sus respectivos alumnos. Los docentes fueron conminados a aprender sobre la definición, teoría, usos y alcances de los mapas conceptuales. Al tiempo que eran evaluados a través de encuestas dirigidas a conocer tanto sus avances respecto a su conocimiento de los mapas conceptuales, como a conocer los presupuestos previos que los mismos docentes poseían respecto a los organizadores gráficos, la conceptualización de temas diversos y su utilización concreta en el mapa conceptual. Los profesores docentes lograron comprender el porqué los aprendizajes significativos se incrementan a través de los mapas conceptuales, utilizándolos en tres modalidades: El Mapa Prototipo (lluvia de ideas original), El Mapa Incompleto (recursivo) y Ampliado (terminado). El curso-taller expuso que el mapa conceptual puede ser aplicado a cualquiera de las materias del currículo oficial, logrando a través de los mismos aprendizajes significativos y mejor comprensión tanto en el profesor que los realiza como en los estudiantes que los aprenderán.

1 Introducción

Desde hace cuatro años tanto en la conferencia de mapas conceptuales de Valletta en Malta como en Santos, Brasil, el autor de la presente investigación comenzó a investigar cuales eran los resultados del uso del mapa conceptual en el aprendizaje entre los alumnos de nivel bachillerato en el campo de la Historia. Sin embargo, en esta ocasión ha tenido la oportunidad de trabajar directamente, no con los alumnos, sino con los profesores docentes de las asignaturas del mismo nivel medio (bachillerato) que imparten diferentes materias.

En esta ocasión a diferencia de las dos experiencias previas, la investigación no consistió en saber cual era la mejora en el aprendizaje a través del mapa conceptual de un grupo de alumnos, sino en observar, tratar de explicar y entender cómo los maestros aprendían, entendían y comprendían, antes de usarlos en sus respectivas clases, los llamados mapas conceptuales.

El Instituto donde se llevó a cabo la investigación fue una escuela privada incorporada a la UNAM, en la cual los maestros participantes, pertenecían a diferentes asignaturas escolares tales como Química, Español, Literatura, Lengua Extranjera, Geografía, Pedagogía, Biología, etc. (en promedio fueron nueve asignaturas distintas) Todos ellos tomaron, con el autor del presente texto, un curso-taller, que duró un mes, para aprender a construir, reconocer, realizar y utilizar mapas conceptuales en sus respectivas materias.

Se expone también en el presente trabajo cuales fueron sus principales inquietudes, generadoras de cambio, así como sus observaciones sobre la implementación de los mapas conceptuales en sus diferentes asignaturas.

2 Objetivos

Uno de los objetivos del presente estudio o investigación fue reconocer estadísticamente cuales eran los intereses de los profesores docentes de diferentes asignaturas tanto al aprender a construir mapas conceptuales, como al aplicarlos y ejecutarlos en sus diferentes materias. Es decir, una investigación en primera instancia descriptiva del cómo se aprende a nivel docente la realización del mapa conceptual. En segunda instancia, se intentó obtener una investigación explicativa del porqué los maestros preferían hacer un mapa conceptual de un tipo mas bien que de otro. Y finalmente una investigación generadora de cambio, en el sentido de conocer, así mismo, la receptividad y aportaciones que los docentes pudieran ofrecer a la utilización del mapa conceptual como un ordenador gráfico especialmente calificado para sus respectivas asignaturas.

Otro objetivo del curso-taller fue hacer conocer cuales son los criterios y técnicas principales para construir los mapas conceptuales y unificar u homogenizar criterios tanto en la elaboración de los mismos, como en las rúbricas para calificarlos dentro de la institución en la que se impartió el curso-taller correspondiente. De esta forma, con la finalidad de mostrar la pertinencia del mapa conceptual como un organizador gráfico universal, y con la finalidad de descubrir las impresiones de los docentes respecto al mismo, se describe, se explica y se plantea cuales fueron los resultados.

Por supuesto, nuevamente, no se piensa que los resultados sean definitorios, completos y acabados. Sin embargo, el autor cree que pueden ser una aportación a la teoría y técnica del mapa conceptual

3 Referencial Teórico

El autor utilizó como texto de base, para el curso-taller aunque no siguiéndolo de manera literal, sino adaptándolo a sus propias necesidades, a las del taller y a las necesidades de los docentes; el texto de Manuel F. Aguilar T., de la Universidad Autónoma del Estado de Morelos (UAEM), "Didáctica del mapa conceptual en la educación superior" (2012). Se utilizó también el aparto referencial de Ausubel (2000), respecto a la concepción del aprendizaje significativo, y se aplicaron marcos de referencia usados tanto en la lógica descriptiva, en la lógica conceptual, así como en la lingüística general y en la filosofía del lenguaje de la fenomenología de los conceptos. Tales como las distinciones entre conceptos por intencionalidad (comprensibilidad), extensionalidad, así como las distinciones entre proposiciones apodícticas, asertóricas, hipotéticas y analíticas y sus variedades lógicas cuantitativas (universales, particulares y singulares). De acuerdo a la lógica clásica.

Respecto a la justificación del uso del referencial teórico de la lógica clásica considérese la siguiente cita del Mtro. Molina Zambrano (2007):

> "A la lógica le interesa el contenido del juicio, es decir, su intencionalidad, la cual consiste en la predicación, en el hecho de atribuir algo a un sujeto. Así pues, *el juicio psicológico es la operación que causa el juicio lógico, el cual afirma o niega algo de un sujeto, y el juicio lógico tiene su signo en la proposición."*

Es de observar, sobre todo para los lectores de lengua inglesa, que el uso del término proposición, viene usado así en el curso-taller, y no en la modalidad de la filosofía analítica en donde se distingue entre "sentence" (la oración como un "element grammatical"), "statement" (como una afirmación donde se expresa un asentimiento o compromiso con su contenido) y "proposition" (que es el contenido propiamente dicho).

En tanto, para la investigación sobre los intereses, aprendizaje y comprensión del taller el autor usó la plataforma de encuestas y análisis surveymonkey.com. A través de las mismas se pudo evaluar tanto los intereses, como la comprensión de los profesores.

El autor partió de que los maestros de las diferentes asignaturas al tomar el curso-taller además de poseer diferentes bagajes, no tenían ningún referencial teórico de los mapas conceptuales, más que aquel que ellos, por algún motivo, hubieran realizado previamente (Ausubel, D.P. , Novak, J.D. y Hanesian, H., 1983), y por tanto, el curso-taller comenzó con preguntas dirigidas a saber qué concepción existía entre los maestros respecto a los llamados organizadores gráficos (Novak, J. D. & A. J. Cañas, 2006), así como sus diferencias con el llamado mapa conceptual.

4 Metodología o Procedimiento

4.1 Descripción del Taller

La investigación se llevó a cabo con 9 maestros de educación media superior (llamado preparatoria en México). Cada maestro debía tomar 9 clases del curso-taller, que eran evaluadas en línea en la siguiente clase a través de los cuestionarios realizados por medio de *Surveymonkey* una vez que se les daba la clave o *password* para poder realizarlas. El total de sesiones también fue evaluado por los propios docentes en la última sesión del curso-taller. Observando diferentes criterios tales como la comprensión en la formación de conceptos y de proposiciones. Los cuales sirven como criterios fundamentales en la técnica de realización del mapa conceptual y en la evaluación o rúbrica del mismo.

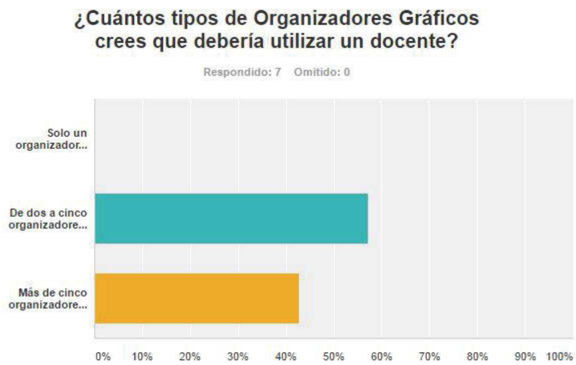
Para poder dictar el curso-taller, los recursos didácticos utilizados para la investigación fueron el *CmapTools*, el pizarrón electrónico *Interwrite Learning*, pantallas de Tv, la página de encuestas Surveymonkey, música de fondo y plumones tradicionales de tinta para representar el conocimiento adquirido durante el curso-taller. En todas las sesiones se usó también videoproyector y presentaciones de diapositivas.

Las partes que constituyeron el curso-taller correspondieron en gran parte al método de enseñanza de mapas conceptuales de Manuel F. Aguilar Tamayo utilizando también las categorías de Ausubel de modo que aprendieran a identificar, como ya lo venía haciendo el autor con sus alumnos de la materia de Historia, las categorías de los conceptos que pueden ser clasificados en grupos de comprensión más universal (subsumidores), además de aprender también a distinguir entre conceptos que se pueden utilizar como sujetos de las proposiciones (conceptos específicos, manejados en el curso de manera lógica como conceptos unívocos o intencionales) y aquellos que se pueden utilizar como predicados de las proposiciones (conceptos generales, manejados de manera específica a través del término lógico de conceptos equívocos o comprensibles). Con el objetivo de lograr establecer proposiciones concretas y comprensibles para todo aquel que lee el mapa conceptual. El resultado fue muy interesante para los mismos maestros, al descubrir que al elaborar una proposición puede existir cierta intencionalidad del realizador de un mapa conceptual, ya sea de hacer proposiciones polisémicas o equívocas (Santos 1984) en el mismo mapa, o bien, de dejar cierto margen de error en la conceptualización del mismo para permitir la recursividad del mapa conceptual (dejando libres o incompletas algunas secciones del mapa conceptual bajo el principio del abandono de la narrativa (Moreira 2000)

Figura 1. Primeros apuntes de un docente sobre la categorización de un mapa conceptual.

En primera instancia se hizo patente la diferenciación entre conocer y entender un mapa conceptual. Es decir, la diferencia entre conocer la existencia de los mapas conceptuales y tomar conciencia de lo que se conoce (entender) sobre el mapa conceptual. Con la finalidad de hacer patente que después de este curso-taller no solo se iba a conocer el mapa conceptual, sino a entenderlo de una manera más profunda y significativa.

Para empezar, se trató el tema de cuántos organizadores gráficos conocían los docentes, cuáles eran las diferencias entre los mismos y cuántos eran los organizadores que un docente idealmente tendría que enseñar a su alumnado.



Opciones de respuesta	Respuestas	
Solo un organizador gráfico	0,00%	0
De dos a cinco organizadores gráficos	57,14%	4
Más de cinco organizadores gráficos	42,86%	3
Total		7

Figura 2. Pregunta 19 del curso taller sobre los tipos de mapa conceptual.

Una vez establecida cual era la posición del mapa conceptual junto a otros organizadores gráficos, se procedió a explicar el manejo de conceptos claros (por su intencionalidad) y se pasó al manejo de proposiciones claras, de tal modo que se comprendiera adecuadamente el papel de los conceptos enlace y su función de implicación o de exclusión según los casos.

Se hicieron ejercicios y ejemplos del papel de los enlaces cruzados en los mapas conceptuales, como una forma de ampliar el contenido de las proposiciones, haciendo de esta manera al mapa conceptual un organizador gráfico más dinámico, evitando su papel estático en la enseñanza, para enriquecer el conocimiento de los maestros y alumnos (Derbentseva, *et al*. 2006). En este sentido, se debatió también el concepto de bidireccionalidad y circularidad del mapa conceptual (Safayeni, Derbentseva, & Cañas, 2005).

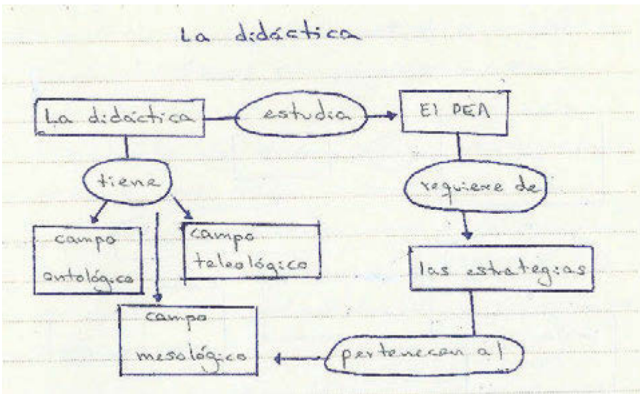
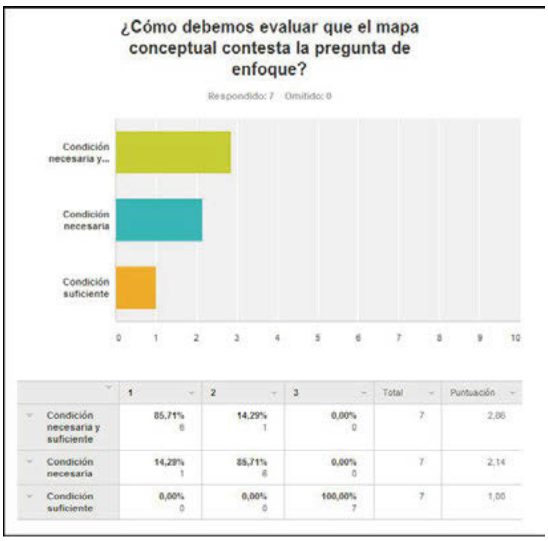


Figura 3. Ejemplo de un docente sobre la circularidad del mapa conceptual.

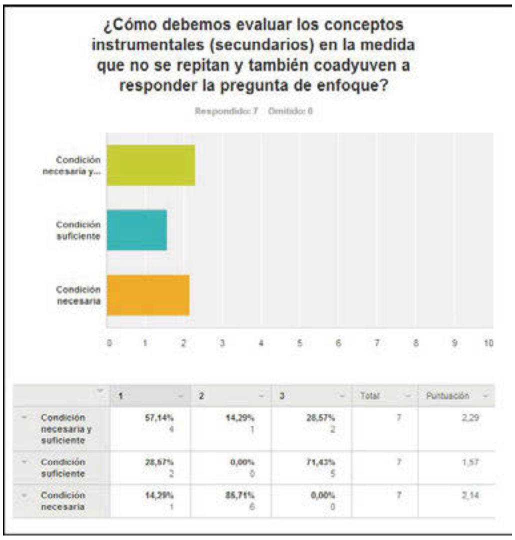
A continuación, se ahondó en la práctica de proposiciones y de preguntas de enfoque de tipo problemático, cuantitativas (universales, particulares y singulares), apodícticas, asertóricas, hipotéticas y analíticas. Basándose el autor nuevamente en principios teóricos de la lógica formal (tradicional) y de la filosofía del lenguaje.

Y antes de terminar, se analizó que criterios debían ser considerados en la creación de una rúbrica que evaluara los mapas conceptuales dentro de la institución. Evaluando estos criterios de acuerdo nuevamente a los principios de la lógica formal y la filosofía del lenguaje. En primera instancia, se planteó que el objetivo principal es que el mapa conceptual conteste la pregunta de enfoque. De acuerdo a ello se plantearon tres posibles escenarios hipotéticos de rúbrica: *(1)* que el mapa conceptual realizado por el alumno contenga condiciones suficientes, *(2)* condiciones necesarias y *(3)* condiciones necesarias y suficientes.



	1	2	3	Total	Puntuación
Condición necesaria y suficiente	85,71% 6	14,29% 1	0,00% 0	7	2,86
Condición necesaria	14,29% 1	85,71% 6	0,00% 0	7	2,14
Condición suficiente	0,00% 0	0,00% 0	100,00% 7	7	1,00

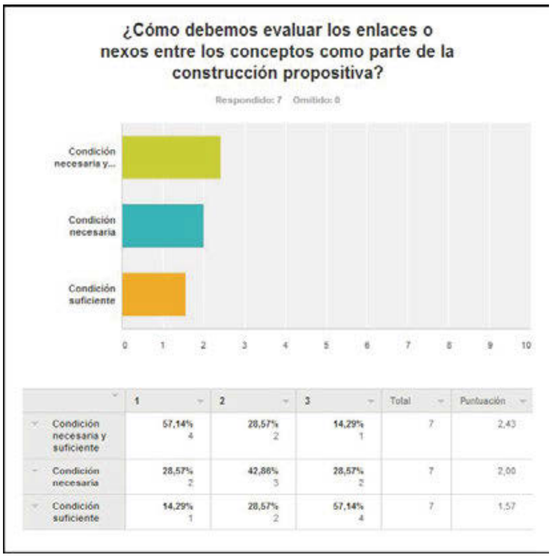
Figura 4. Pregunta 31 del curso taller sobre las rúbricas del mapa conceptual.



	1	2	3	Total	Puntuación
Condición necesaria y suficiente	57,14% 4	14,29% 1	28,57% 2	7	2,29
Condición suficiente	28,57% 2	0,00% 0	71,43% 5	7	1,57
Condición necesaria	14,29% 1	85,71% 6	0,00% 0	7	2,14

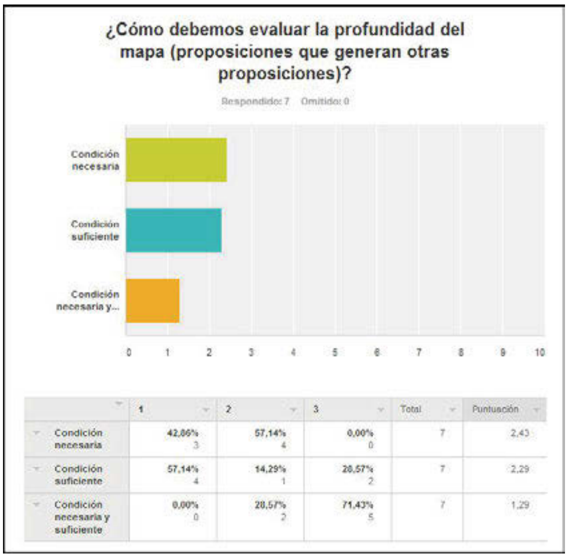
Figura 5. Pregunta 32 sobre Rúbricas.

Evaluando de la misma manera los conceptos *instrumentales* o *subordinados* (secundarios) en cuanto a su coadyuvancia para responder preguntas de enfoque. Por otro lado, también se estableció cómo evaluar los *enlaces* o *nexos* entre los conceptos, cómo evaluar los *enlaces* creativos, novedosos y circulares. La *profundidad o complejidad* del mapa (proposiciones que generan otras proposiciones) y la *legibilidad* del mismo (linealidad, concordancia y categorización). En muchos aspectos, los resultados de cómo unificar las rúbricas en la institución fueron similares a los resultados obtenidos por Domínguez Marrufo, L. S. et al. (2010).



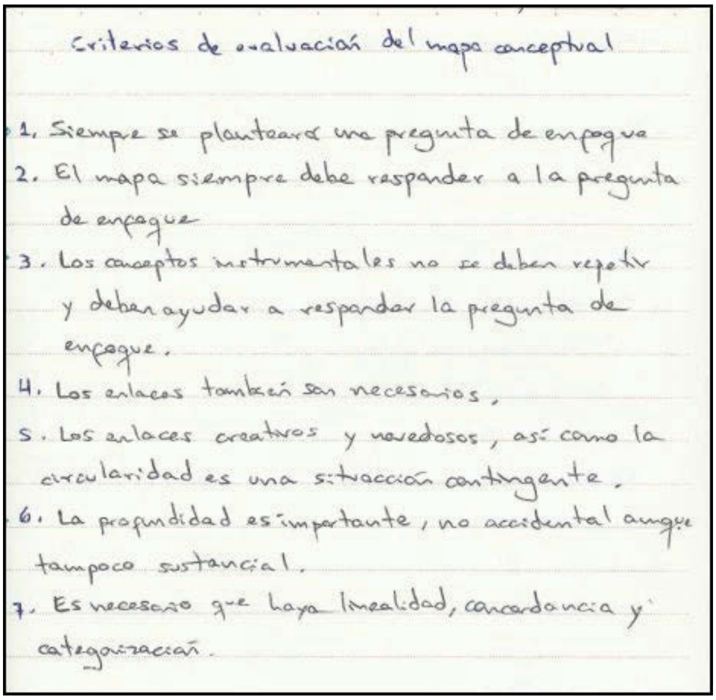
	1	2	3	Total	Puntuación
Condición necesaria y suficiente	57,14% 4	28,57% 2	14,29% 1	7	2,43
Condición necesaria	28,57% 2	42,86% 3	28,57% 2	7	2,00
Condición suficiente	14,29% 1	28,57% 2	57,14% 4	7	1,57

Figura 6. Pregunta 33 del curso taller sobre las rúbricas del mapa conceptual.



	1	2	3	Total	Puntuación
Condición necesaria	42,86% 3	57,14% 4	0,00% 0	7	2,43
Condición suficiente	57,14% 4	14,29% 1	28,57% 2	7	2,29
Condición necesaria y suficiente	0,00% 0	28,57% 2	71,43% 5	7	1,29

Figura 7. Pregunta 34 sobre Rúbricas.


Criterios de evaluación del mapa conceptual

1. Siempre se planteará una pregunta de enfoque
2. El mapa siempre debe responder a la pregunta de enfoque
3. Los conceptos instrumentales no se deben repetir y deben ayudar a responder la pregunta de enfoque.
4. Los enlaces también son necesarios,
5. Los enlaces creativos y novedosos, así como la circularidad es una situación contingente.
6. La profundidad es importante, no accidental aunque tampoco sustancial.
7. Es necesario que haya linealidad, concordancia y categorización.

Figura 8. Criterios de evaluación escritos por un docente para evaluar el mapa conceptual.

Finalmente se realizó una coevaluación entre los docentes, así como una autoevaluación de cada uno y una heteroevaluación del curso-taller como tal. Siendo los resultados bastante gratificantes.

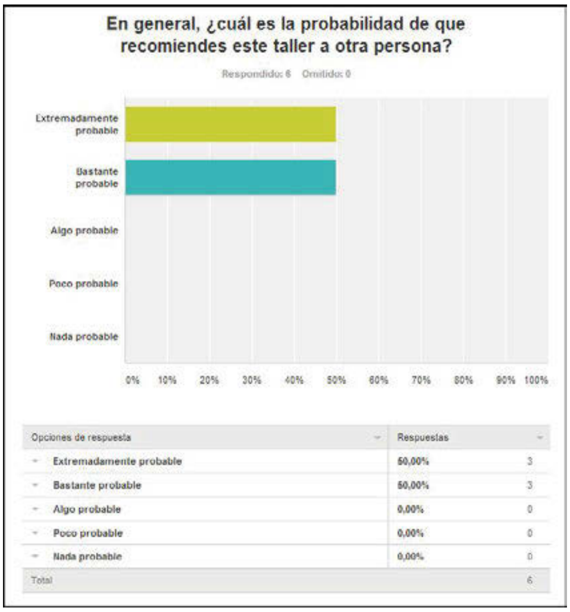
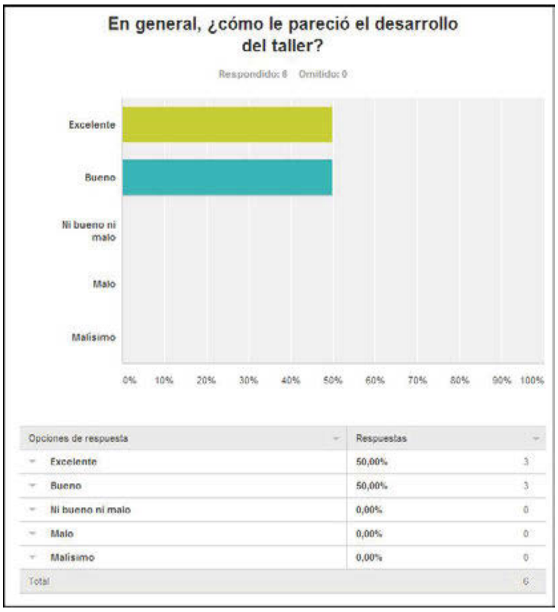


Figura 9. Pregunta 37 del curso taller heteroevaluación de los docentes.



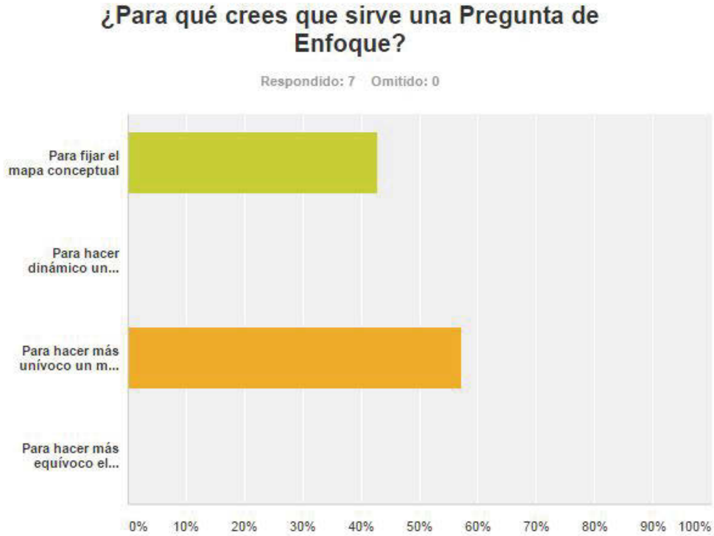
. **Figura 10**. Pregunta 42 sobre la heteroevaluación.

4.2 Explicación de los resultados del Curso-Taller

En primera instancia, el hecho de problematizar al mapa conceptual como un organizador gráfico, fue muy útil para interpretar el conocimiento previo (o subsumidores de Ausubel) de los maestros. El debate sobre el uso de los mapas conceptuales como organizadores previos o como organizadores a posteriori, se ha investigado previamente fuera y dentro de la misma conferencia internacional de mapas conceptuales (Lima 2004 y Camilotti, Brinatti, Borges y Ruíz, 2014). La mayoría de los profesores no conocía más de cinco organizadores gráficos, pero a lo largo del curso-taller también se mostraron más organizadores (tales como el diagrama en V o UVE) con la finalidad de hacer los comparativos pertinentes con el mapa conceptual. Sobre todo, al descubrir que el mapa conceptual no solo sirve para las ciencias formales o abstractas, que era una de las percepciones dominantes, sino para toda clase de ciencias.

La definición cognitiva de proposición, también generó ideas muy interesantes, desde la simple sinonimia con la definición de un juicio (al modo de la lógica tradicional), pasando por el concepto sintáctico de expresión que está subordinada a otra expresión (lingüística), hasta llegar a la concepción de que toda proposición es la enunciación de una verdad o algo que se pretende demostrar como tal.

Respecto a cómo generar mapas conceptuales que tomen en consideración adecuadas relaciones semánticas y lógicas, es de notar que a veces en el orden de un 11% se llegó a presentar una confusión entre la inclusividad (comprensibilidad) y exclusividad (intencionalidad) de los conceptos, lo cual podría explicar en algunas ocasiones por qué se prefieren mapas conceptuales polisémicos, en función de la falta de claridad cognitiva. No obstante, no se debe interpretar que en la mayoría de los casos sea debido a eso.



Opciones de respuesta	Respuestas	
Para fijar el mapa conceptual	42,86%	3
Para hacer dinámico un mapa conceptual	0,00%	0
Para hacer más unívoco un mapa conceptual	57,14%	4
Para hacer más equívoco el mapa conceptual	0,00%	0
Total		7

Figura 11. Pregunta 13 del curso taller sobre las preguntas de enfoque del mapa conceptual.

Se tuvo que demostrar el por qué un mapa conceptual auténticamente bidireccional tenía que estar compuesto fundamentalmente de proposiciones analíticas, pues de otra manera las inclusiones no podrían ser comprensibles en sentidos opuestos. A la vez que en la circularidad de ciertos mapas conceptuales se movía la comprensión de lo inclusivo a lo exclusivo y viceversa.

Otro aspecto a considerar es el uso de la pregunta de enfoque, casi la mitad de los mismos, creía en un principio, que la pregunta de enfoque era para fijar el mapa conceptual en un resultado concreto y esperado, haciéndolo unívoco (o monosémico) como Gowin (1981) sugiere en su obra *Educating* y que efectivamente es la finalidad de muchos mapas conceptuales. Sin embargo, después de aprender a realizar preguntas de enfoque dinámicas, reconceptualizaron la pregunta de enfoque desde otra perspectiva e incluso la prefirieron a aquellas preguntas de enfoque estáticas.

4.3 Conceptos generadores de Cambio dentro del Curso-Taller.

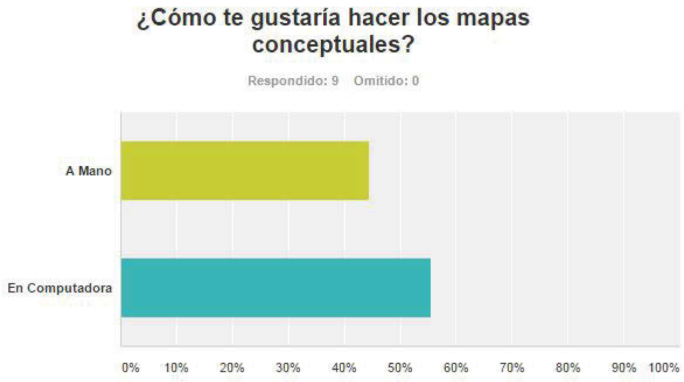
La mayoría de los profesores no conocía más de cinco organizadores gráficos, pero a lo largo del curso-taller llegaron a la conclusión de que era deseable conocer de dos a cinco organizadores gráficos, siendo prioritario el mapa conceptual como un organizador con mucho potencial debido a sus propiedades polisémicas.

Se llegó a la conclusión entre los docentes que a mayor dinamismo del mapa conceptual, menos jerarquización, ya que los mapas jerarquizados tendían a ser más estáticos. Por lo cual, a menos que se deseara una memorización del mismo, era preferible el mapa conceptual dinámico.

Respecto a las rúbricas para la evaluación del mapa conceptual fue muy interesante que los maestros a pesar de provenir de diferentes áreas del conocimiento concordaron en que se debe insistir en que el aprendizaje de la construcción de mapas conceptuales debe poner énfasis en la construcción de conceptos y de las proposiciones adecuándose a los fundamentos teóricos de la materia en cuestión. Clasificando diversos aspectos del mapa conceptual como suficientes, otros como necesarios y finalmente con el doble aspecto de necesarios y suficientes.

5 Evaluación y Resultados

Los resultados fueron múltiples, por ejemplo, al inicio del curso al autor le llamó mucho la atención que el 44% de los maestros prefirieran hacer los mapas conceptuales a mano. Por supuesto, al final del curso la mayoría reconoció la gran ventaja que representaba usar una herramienta como *CmapTools*.



Opciones de respuesta	Respuestas	
A Mano	44,44%	4
En Computadora	55,56%	5
Total		9

Figura 12. Pregunta 8 del curso taller sobre la técnica del mapa conceptual.

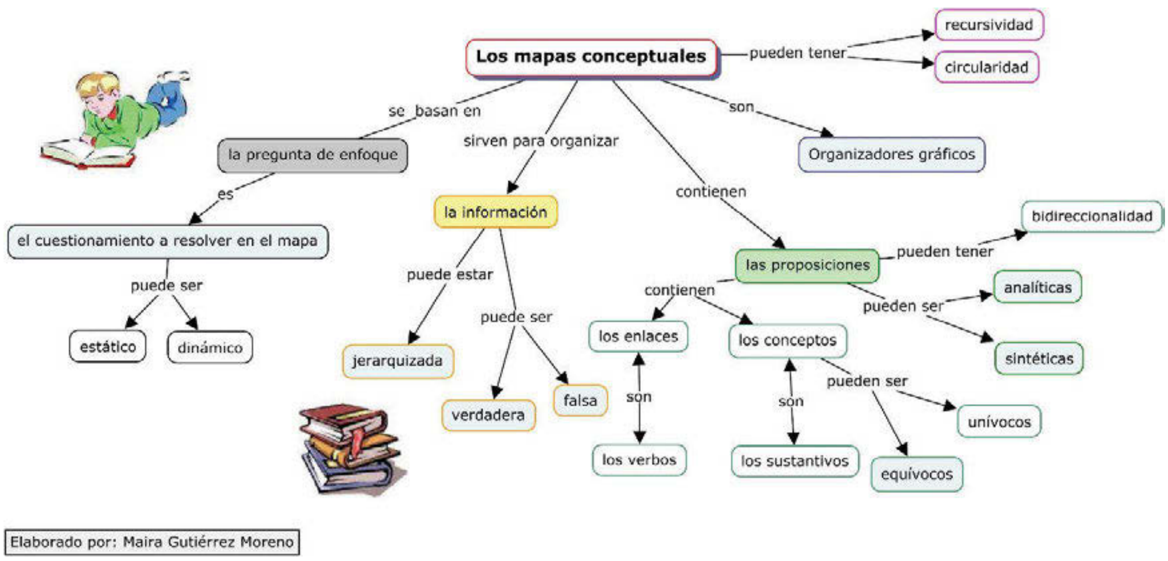


Figura 13. Mapa Conceptual que presentó una maestra al terminar el curso.

Se planteó que la finalidad del mapa conceptual es responder a las llamadas preguntas de enfoque. Sin embargo, se percataron que la pregunta de enfoque puede llegar a limitar el dinamismo del mismo mapa conceptual fijándolo y haciéndolo más monosémico o unívoco, y por tanto más estático. De tal modo, que en algunas ocasiones declararon que preferirían hacer el mapa conceptual sin una pregunta de enfoque inicial con la finalidad de obtener mapas conceptuales prototipo (lluvia de ideas) o recursivos (incompletos). O en su caso, hacer preguntas de enfoque con mayor o menor comprensibilidad según el enfoque que quisieran lograr. Por tanto, llegaron a la conclusión de que las preguntas de enfoque debían de ser en algunas ocasiones monosémicas o unívocas, de alta intencionalidad y en otras polisémicas o equívocas, de mayor comprensibilidad, dependiendo del resultado que se deseara lograr en los alumnos.

Fue abrumador el resultado mayoritario de los maestros que deseaban hacer mapas conceptuales de tipo dinámico, una vez comprendido el por qué era dinámico, sobre el estático. Así que, prefirieron preguntas de enfoque dinámicas, sobre las estáticas. Haciendo ver que al conocimiento previo que disponían sobre el mapa conceptual, se había generado un cambio conceptual en función del aprendizaje del curso-taller. Y descubrieron que a través de este tipo de preguntas polisémicas podían lograr mapas conceptuales más acordes a sus respectivas materias.

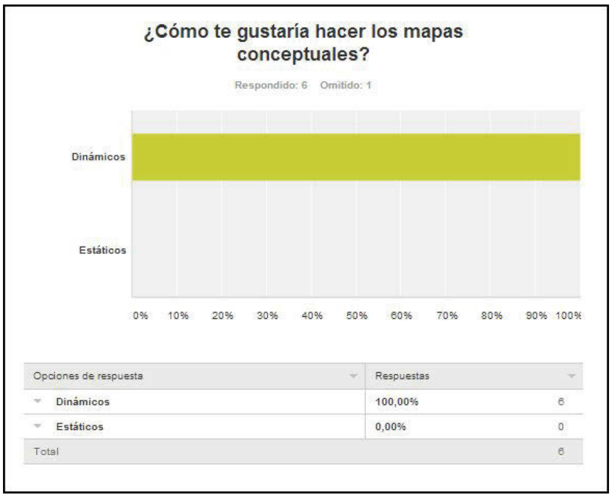


Figura 14. Pregunta 19 del curso taller sobre los tipos de mapa conceptual.

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Y claro, mención aparte, a la niña de mis ojos: Isabella Romo Sepold, así como a la correctora de estilo, su mami, Michelle Sepold que tanto nos ha apoyado.

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UM TREINAMENTO EM DUAS ETAPAS VISANDO À CERTIFICAÇÃO DE MAPEADORES EXCELENTES: DA REPRESENTAÇÃO À MODELAGEM DE CONHECIMENTO

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Resumo. O treinamento de usuários na técnica de mapeamento conceitual é condição indispensável para assegurar a alta qualidade do mapa conceitual (MC) em termos de estrutura gráfica e precisão do conteúdo. Porém, avaliar a excelência na técnica por meio da qualidade de estrutura e conteúdo é tarefa complexa. Esse trabalho tem como objetivo propor um treinamento sequencial em duas etapas. A primeira etapa requer o cumprimento de objetivos de baixa ordem cognitiva (lembrar, entender, aplicar) para capacitar novatos a bons mapeadores, desenvolvendo habilidades de representação do conhecimento por meio dos MCs. A segunda etapa requer o cumprimento de objetivos de alta ordem cognitiva (analisar, avaliar e criar) para capacitar bons a excelentes mapeadores, desenvolvendo habilidade de modelagem do conhecimento por meio dos MCs. Aportes teóricos são oferecidos para (1) apresentar parâmetros de referência que distinguem bons e excelentes MCs; (2) informar a produção de tarefas instrucionais, considerando a taxonomia revisada de Bloom e a teoria da carga cognitiva; (3) propor um protótipo de treinamento em mapeamento conceitual combinando atividades à distância e presenciais. A aplicação do treinamento proposto e a busca por uma certificação institucional são os próximos passos para a utilização madura dos MCs.

1 Introdução

Mapas conceituais (MCs) são ferramentas gráficas que representam o conhecimento explicitando a relação entre dois conceitos por meio de proposições. Os conceitos são hierarquicamente organizados e a rede proposicional tem o objetivo de responder à uma pergunta focal (Cañas & Novak, 2006). De acordo com Cañas, Novak e Reiska (2015) existe uma diferença entre bons MCs e excelentes MCs (Figura 1). Bons MCs devem preencher requisitos ou métricas relacionados à estrutura gráfica e à precisão do conteúdo mapeado, tais como responder a uma pergunta focal específica, apresentar uma organização dos conceitos hierarquicamente do mais geral para o mais específico, ter proposições corretas e relevantes. Entretanto, nenhum desses requisitos garante um MC excelente, que precisa ser conciso, bem estruturado e capaz de capturar a complexidade do conteúdo envolvido.

A qualidade de um MC está intimamente relacionada à proficiência na técnica e ao nível de conhecimento do mapeador sobre o tema a ser representado. Quanto maior a proficiência e o conhecimento do mapeador, maior a qualidade do MC. Entretanto, avaliar essa qualidade é tarefa complexa. Apesar de Cañas, Novak e Reiska (2015) apresentarem importantes considerações sobre como reconhecer MCs excelentes, eles também afirmam que:

Um MC excelente é como um bom poema, você sabe quando o lê, porém, não se sabe como quantificar a razão. Mapeadores profissionais conseguem reconhecer um MC excelente, mas é difícil ensinar como construí-lo (Cañas, Novak & Reiska, 2015, p. 17, tradução nossa).

As dificuldades apontadas passam por entender uma série de perguntas ainda sem respostas, como, por exemplo: *Como nos tornamos mapeadores excelentes? Quais competências devem ser desenvolvidas para se tornar um excelente mapeador? Quais as características de MCs excelentes? E, como esses MCs podem ser distinguidos de bons MCs?* Nosso grupo vem se dedicando à pesquisas voltadas ao desenvolvimento e aplicação de atividades de treinamento capaz de tornar novatos em bons mapeadores (Aguiar & Correia, 2014; Aguiar, Cicuto & Correia, 2014). A Teoria da Carga Cognitiva nos oferece um panorama teórico que norteia a escolha das melhores estratégias instrucionais em cada etapa desse treinamento (Correia & Aguiar, 2014). Os resultados obtidos até o momento são promissores e a possibilidade de disseminação em larga escala se torna possível com a adaptação dessas atividades por meio de plataformas de ensino à distância.

Esse trabalho tem como objetivo propor um treinamento sequencial em duas etapas para formar mapeadores excelentes (linhas vermelha e verde na Figura 1). A primeira etapa oferece atividades à distância, mediadas por computador, para capacitar novatos na organização e representação do conhecimento na forma de MCs (Tabela 1). A segunda etapa prevê atividades presenciais para capacitar bons mapeadores na modelagem do conhecimento usando MCs, levando-os a condição de mapeadores excelentes (Tabela 1).

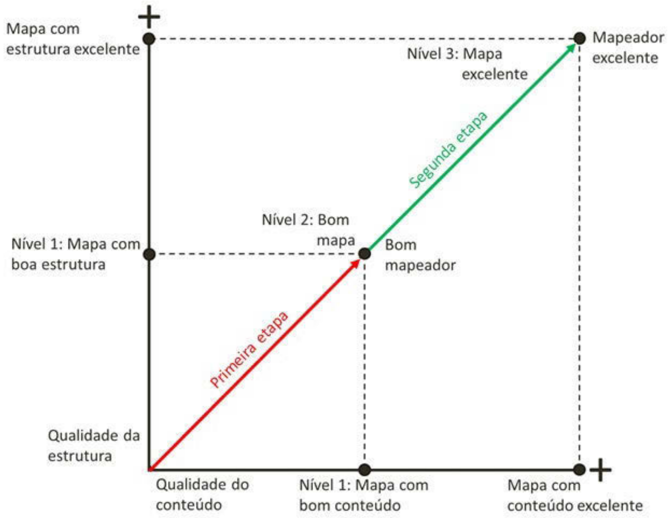

Figura 1. Estrutura gráfica e precisão do conteúdo são critérios que definem a qualidade dos MCs. Bons mapeadores combinam boa estrutura (nível 1) com bom conteúdo (nível 1) para fazer bons MCs (nível 2). Mapeadores excelentes elaboram MCs excelentes (nível 3), com alta qualidade geral, de estrutura e de conteúdo. Traduzido e adaptado com permissão de Cañas, Novak & Reiska (2015).

	Primeira etapa	**Segunda etapa**
Formato das atividades	*Online*, mediadas por computador	Presencial
Foco principal	Representação do conhecimento	Modelagem do conhecimento
Nível do mapeador	Novato a bom mapeador	Bom mapeador a excelente mapeador

Tabela 1: Características gerais que diferenciam as duas etapas sequenciais de treinamento em MCs proposto nesse trabalho.

A sustentação dessa proposta é feita a partir de discussões teóricas que cumprem três objetivos específicos:

- Distinguir bons MCs e excelentes MCs, oferecendo parâmetros de referência para avaliar a qualidade do MC e a proficiência dos mapeadores.
- Caracterizar as tarefas instrucionais necessárias para cumprir as duas etapas de treinamento.
- Propor um protótipo do treinamento orientado à certificação de mapeadores excelentes.

2 Parâmetros para ditinguir mapas conceituais bons e excelentes

Os MCs são constituídos por duas características fundamentais: a estrutura gráfica e o conteúdo semântico. A estrutura diz respeito aos aspectos de layout visual tais como: o número e localização de conceitos e proposições, a disposição hierárquica dos conceitos, o tamanho do MC e a proporção entre conceitos e proposições, aspectos de legibilidade e fluxo proposicional, a quantidade de setas indicando ordem de leitura, a realização de ligações cruzadas, o uso de cores ou outras dicas gráficas de navegação, entre outros. Já o conteúdo semântico diz respeito a validade e pertinência dos conceitos, termos de ligações e proposições, a pertinência da hierarquia, a aderência à pergunta focal, relações conceituais entre diferentes sub-domínios presentes no MC, a presença de exemplos, entre outros. As características de estrutura e conteúdo permitem avaliar a qualidade de um MC, a partir dos quatro elementos centrais que os constituem (Cañas & Novak, 2008; Aguiar & Correia, 2014):

- As **proposições** devem ter alta clareza semântica e comunicar com precisão as relações conceituais representadas.
- A **pergunta focal** delimita o conteúdo a ser mapeado e é a forma mais eficiente para controlar o tamanho do MC.
- A organização dos conceitos deve apresentar **hierarquia**, sendo que os conceitos mais gerais (abrangentes) iniciam o mapa e são progressivamente detalhados.
- As **revisões contínuas** do MC devem ser utilizadas para modificar o conhecimento representado, de acordo com as mudanças de entendimento conceitual do mapeador.

A Tabela 2 apresenta uma combinação entre os quatro elementos centrais citados acima considerando sua contribuição a favor da estrutura ou do conteúdo do MC. A Tabela 2 norteia os parâmetros de referência que caracterizam e diferenciam bons MCs e excelentes MCs.

Os bons MCs são aqueles que cumprem os critérios estabelecidos na diagonal (em preto) da Tabela 2. Para se tornar um bom mapeador, cada elemento central deve ser compreendido e manipulado de modo unitário, ou seja, o sujeito precisa incorporar, passo-a-passo, esses parâmetros à medida que aprende a técnica. A revisão contínua é uma boa estratégia que permite inicialmente listar conceitos (eventos ou objetos), em seguida organizá-los hierarquicamente do mais geral ao mais específico, depois estabelecer proposições corretas e claras e, por fim, definir uma pergunta focal. Esse processo garante uma boa organização e representação do conteúdo, a partir da união das partes (proposições com conceitos hierarquicamente organizados) culminando no todo (um bom MC que responde à uma pergunta focal específica). É possível avaliar o bom mapeador como sendo aquele que manipula os elementos centrais para garantir uma boa representação do conhecimento.

Os MCs considerados excelentes são aqueles que cumprem tanto os critérios estabelecidos na diagonal como aqueles descritos nas demais células (em branco) da Tabela 2. Para se tornar um mapeador excelente os elementos centrais precisam ser compreendidos e manipulados a partir de suas múltiplas combinações. Por exemplo:

- Alterações na pergunta focal norteiam a escolha de novos conceitos e proposições (pergunta focal em conteúdo/proposição em estrutura).
- A hierarquia pode ser organizada de modo cíclico em função de uma nova pergunta focal ou de relações conceituais de causa-consequência (pergunta focal em conteúdo/hierarquia em estrutura).
- Ligações cruzadas podem ser mais facilmente definidas quando a hierarquia destaca sub-domínios de conhecimento (hierarquia em conteúdo/proposição em estrutura).

A revisão contínua é novamente uma boa estratégia que permite o refinamento do todo (um MC mais conciso e fiel à complexidade do conteúdo) a partir da interrelação entre as partes (os elementos centrais). É possível avaliar o mapeador excelente como sendo aquele que manipula a combinação dos múltiplos elementos centrais para garantir uma boa modelagem do conhecimento (alta qualidade de estrutura e conteúdo).

3 Taxonomia Revisada de Bloom e Teoria da Carga Cognitiva para informar as tarefas de treinamento

Nos últimos anos os MCs vem sendo usados para realizar gestão do conhecimento, entendida como um processo que requer organização, representação, refinamento e compartilhamento de conhecimento especializado (Newbern & Dansereau, 1995; Cañas, Leake & Wilson, 1999; Fischer & Mandl, 2001; Coffey *et al.*, 2002; Tergan, Graber & Reinmann-Rothmeier, 2003; Tergan, 2005; Hoffman *et al.*, 2008; Novak, 2010; Correia, 2012). O treinamento proposto nesse trabalho divide a habilidade de gerir conhecimento por meio dos MCs em duas etapas sequenciais:

(1) Organização e representação do conhecimento.
(2) Refinamento do conhecimento (modelagem).

Cada etapa requer processos cognitivos distintos bem como o desenvolvimento de habilidades específicas. A taxonomia revisada de Bloom nos auxilia a classificar os objetivos a serem cumpridos em cada uma dessas etapas de treinamento (Figura 2). Um dos primeiros requisitos para se tornar um bom mapeador é estabelecer uma proposição por meio da união entre dois conceitos com um termo de ligação com verbo. Nesse caso, os objetivos a serem cumpridos pelo mapeador são: (1) *lembrar* que conceitos devem ter poucas palavras, (2) *entender* o conceito de proposição e, (3) *aplicar* o procedimento de unir os conceitos por meio de um verbo que explicite essa relação. Para que o sujeito escolha os conceitos a serem relacionados, bem como o verbo mais adequado para explicitar essa relação, ele deverá dominar não apenas a estrutura das proposições como o conteúdo que está sendo mapeado (relação proposição em estrutura/proposição em conteúdo na Tabela 2). Um bom MC e, consequentemente, um bom mapeador podem ser avaliados a partir do cumprimento dos dois objetivos considerando para avaliação (i) se a estrutura da proposição está correta (dois conceitos, seta que orienta a leitura, verbo no termo de ligação) e (ii) se o termo de ligação escolhido está correto (relação conceitual válida e correta sob o ponto de vista do especialista no conteúdo).

CRITÉRIO FOCADO EM ESTRUTURA GRÁFICA	CRITÉRIO FOCADO EM PRECISÃO DE CONTEÚDO: CONCEITOS & PROPOSIÇÕES	HIERARQUIA	PERGUNTAL FOCAL	REVISÃO CONTÍNUA
CONCEITOS & PROPOSIÇÕES	Rótulo dos conceitos com poucas palavras e que aparece apenas uma vez na rede. Termos de ligação com verbo que explicite corretamente a relação entre o conceito inicial e final. O mapa conceitual é dado pela soma de todas as proposições interligadas (Novak & Cañas, 2010).	Ligações cruzadas – busca por proposições que especifique a interrelação entre dois conceitos em diferentes sub-domínios de conhecimento. Esses sub-domínios estão em diferentes "ramos" hierárquicos do mapa conceitual (Novak & Cañas, 2010).	Mapas conceituais concisos com um número ótimo de conceitos e proposições que sejam inteiramente relevantes para responder à pergunta focal. Parcimônia proposicional e brevidade são necessárias para garantir a legibilidade do mapa conceitual (Derbentseva & Kwants, 2014).	Adicionar, eliminar, revisar e resumir de modo a manter apenas conceitos-chave e uma alta clareza proposicional.
HIERARQUIA	Conceitos e proposições hierarquicamente bem balanceados e bem estruturados que demonstrem entendimento profundo sobre o conteúdo (Carvajal *et al.*, 2006)	Conceitos hierarquicamente organizados. O conceito mais geral é colocado no topo do mapa, que vai sendo progressivamente detalhado em conceitos mais específicos que devem estar na base do mapa (Novak & Cañas, 2010).	O *layout* e o fluxo de leitura semântica devem levar a um aumento da clareza e do nível de entendimento do conteúdo. Diferentes perguntas focais podem requer diferentes tipos de hierarquia, tais como a estrutura cíclica (Safayeni, Derbentseva, & Cañas, 2005) ou em rede (Kinchin & Hay, 2000).	Os conceitos mais inclusivos (*e.g.*, aqueles em que chegam muitas setas) devem ser realocados no topo do mapa. A hierarquia geral do mapa deverá ser revisada a partir dessa mudança.
PERGUNTA FOCAL	As proposições devem ter alta clareza semântica e correção conceitual para que a rede proposicional possa, não apenas responder à pergunta focal, mas também, explicá-la da maneira mais clara possível (Cañas, Novak e Reiska, 2015).	Pergunta focal deve ser definida como um "título" no topo do mapa conceitual, destacando sua importância.	O contexto do mapa conceitual deve ser definido por uma pergunta focal explicitada. A rede proposicional deve responder à essa pergunta (Novak & Cañas, 2010).	Pergunta focal é utilizada para revisar, adicionar e eliminar conceitos bem como reestruturar a hierarquia.
REVISÃO CONTÍNUA	Adicionar, eliminar, revisar e resumir conceitos e proposições de modo a facilitar a navegação e a leitura.	A hierarquia é utilizada como guia para refinar a rede proposicional como um todo. Nesse processo deve-se buscar por ligações cruzadas, exemplos e micro-mapas (*i.e.* mapas menores dentro do mesmo mapa).	A pergunta focal é utilizada como guia para refinar a rede proposicional como um todo. Deve-se buscar selecionar, revisar e resumir proposições, mantendo aquelas que possuem caráter explicativo ao invés de descritivo.	A revisão contínua deve ser utilizada para compreender, aplicar e revisar os critérios para construção de bons mapas conceituais (Aguiar & Correia, 2014).

Tabela 2: Quatro elementos centrais que compõem os MCs (proposições, hierarquia, pergunta focal e revisão contínua), em função do conteúdo e da estrutura. Bons mapas são aqueles que preenchem os pré-requisitos descritos na diagonal (em preto). MCs excelentes devem preencher os pré-requisitos de todas as células.

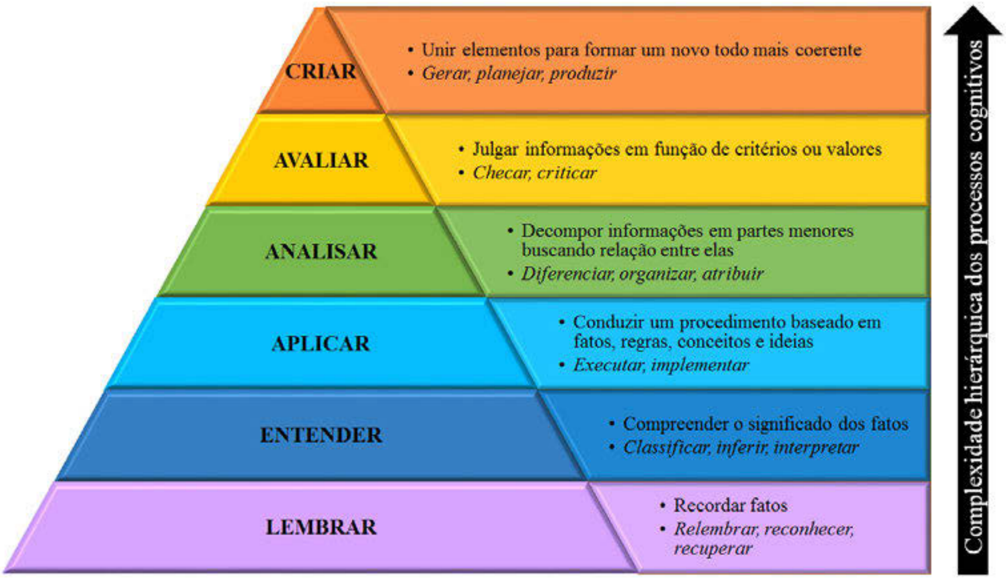

Figura 2. Estrutura da taxonomia revisada de Bloom considerando a dimensão dos processos cognitivos, os quais são hierarquicamente organizados do menos complexo (lembrar) ao mais complexo (criar).

Um mapeador excelente deve ser capaz de refinar o MC de modo a torná-lo mais conciso considerando, por exemplo, um número ótimo de conceitos e proposições relevantes para explicar a pergunta focal (combinação entre pergunta focal em conteúdo/proposição em estrutura na Tabela 2). Nesse caso, o mapeador precisará cumprir os objetivos de (1) *avaliar* a pertinência e validade de conceitos e proposições frente à pergunta focal, (2) *analisar* se a pergunta focal está realmente sendo explicada a cada mudança nos conceitos e proposições e, (3) *criar* uma nova rede conceitual mais concisa e coerente a partir das modificações realizadas. Um mapeador excelente pode ser identificado pelo cumprimento desses objetivos, considerando para avaliação se o MC elaborado posteriormente a esse refinamento está mais conciso e menos descritivo que o anterior.

Nos exemplos dados, ser um bom mapeador envolve atingir objetivos que requerem processos de baixa ordem cognitiva, tais como *lembrar* fatos, *entender* conceitos e *aplicar* regras (Figura 2). Já a excelência na técnica só pode ser atingida mediante cumprimento de objetivos que requerem processo de alta ordem cognitiva, tais como, *avaliar* segundo um critério, *analisar* partes em função da melhoria do todo, além de *criar* um novo todo a partir da melhoria dessas partes (Figura 2). Krathwohl (2002) e Mayer (2002) argumentam que tarefas instrucionais que exigem menor processamento cognitivo devem preceder hierarquicamente aquelas de maior processamento, garantindo um aumento gradual na competência do sujeito sem sobrecarregar seu sistema cognitivo. Em outras palavras, a organização e representação do conhecimento por meio dos MCs deve preceder a modelagem de conhecimento e, ambas as tarefas, devem ser planejadas de modo a evitar a sobrecarga cognitiva.

De acordo com a Teoria da Carga Cognitiva (Sweller, Ayres & Kalyuga, 2011), tarefas instrucionais estão sujeitas a duas cargas cognitivas:

(1) A carga cognitiva intrínseca (I) relativa à complexidade do conteúdo.
(2) A carga cognitiva extrínseca (E) relativa ao formato da instrução.

Ambas as cargas são aditivas e, quando somadas, não podem ultrapassar a memória de trabalho do sujeito, que é limitada em capacidade e processamento. A Figura 3 indica como as cargas cognitivas sofrem alterações à medida em que treinamos os sujeitos a utilizar os MCs para a gestão do conhecimento. Usuários não treinados são mais suscetíveis a sofrer sobrecarga cognitiva durante uma tarefa de elaboração de MCs, uma vez que, precisam organizar um conteúdo novo e complexo (alta carga I) por meio de um organizador gráfico não-familiar (alta carga E). As cargas I e E quando somadas podem ultrapassar a memória de trabalho. O resultado é um MC de baixa qualidade tanto em estrutura como conteúdo, que não representa fielmente a estrutura cognitiva do mapeador (Correia & Aguiar, 2014). Sem a etapa de treinamento é impossível usar o MC para avaliar o conhecimento do sujeito.

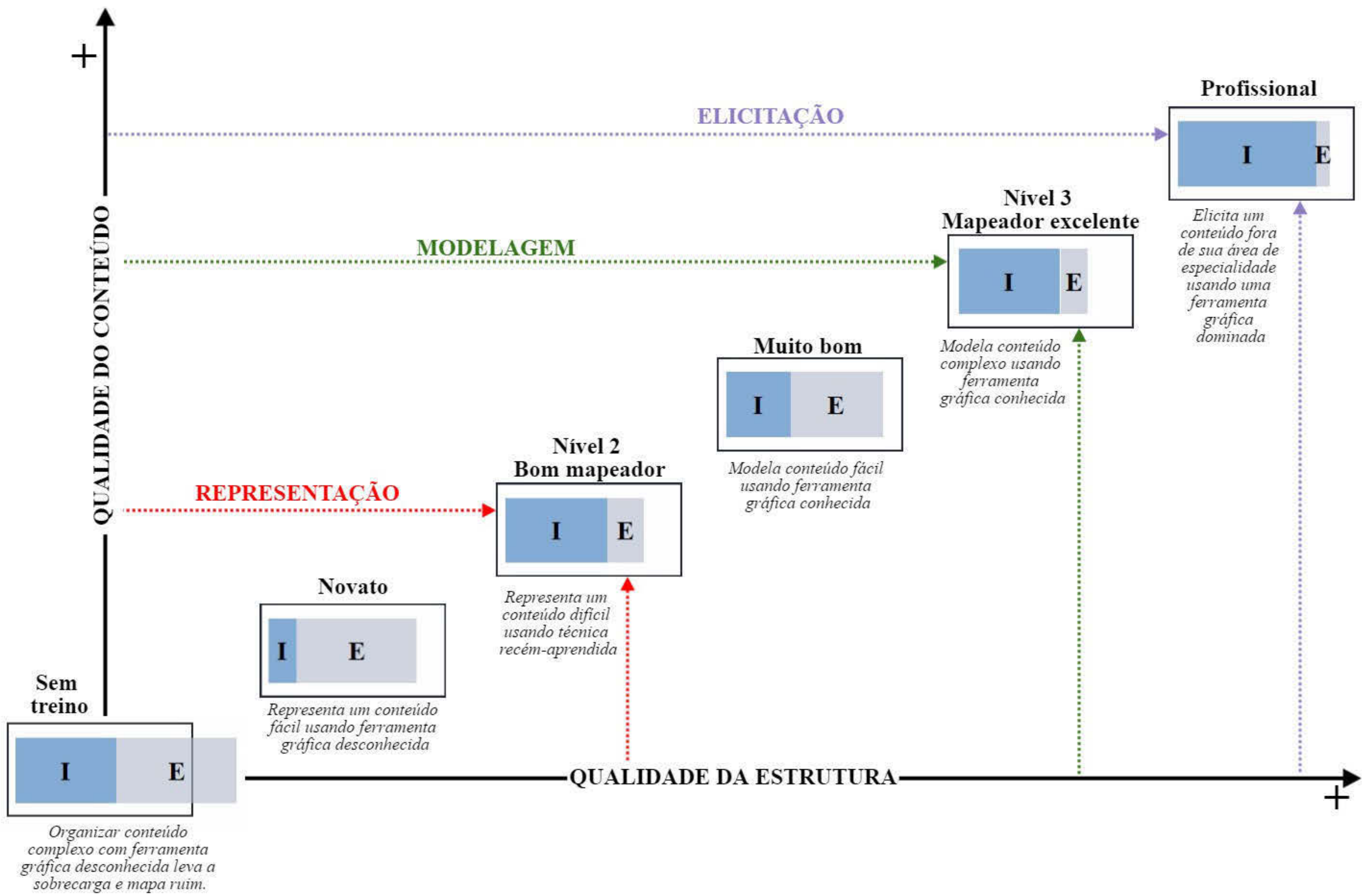

Figura 3. Esquema que ilustra como as cargas cognitivas intrínseca (I, relativa à complexidade do conteúdo) e extrínseca (E, relativa ao formato da tarefa) sofrem alterações durante o treinamento na técnica de mapeamento conceitual. Esse trabalho propõe um treinamento em duas etapas, levando o sujeito de novato à mapeador excelente a partir do desenvolvimento de habilidades voltadas à representação e modelagem do conhecimento. Mapeadores excelentes podem se tornar mapeadores profissionais quando se tornam capazes de realizar elicitação do conhecimento.

A primeira etapa do treinamento implica no sujeito aprender a representar seu conhecimento utilizando os elementos centrais do MC (proposição, hierarquia e pergunta focal). A gestão da carga I é possível pela diminuição da complexidade do conteúdo, sobrando mais recursos na memória de trabalho para lidar com a aprendizagem da técnica, ou seja, para lidar com a carga E imposta pelo uso de um organizador gráfico não-familiar. Depois que o sujeito aprende a manipular os elementos centrais dos MCs para representar seu conhecimento, a carga E é diminuída. A automatização dos processos de representação do conhecimento por meio desse organizador gráfico permite que ele se torne um bom mapeador. A partir desse momento, ele poderá voltar a mapear um conteúdo mais difícil ou complexo, aumentando com isso a carga I associada à tarefa. O resultado deverá ser um MC fiel à estrutura de conhecimento do mapeador, passível de ser fidegignamente avaliado com relação à estrutura e ao conteúdo. A revisão contínua é um elemento crítico para (i) garantir que o sujeito não sofra um processo de sobrecarga cognitiva durante as etapas de aprendizagem sobre a técnica, e (ii) permitir a reconstrução do conhecimento conceitual ao longo do tempo.

A Figura 3 mostra o caminho a ser percorrido do bom ao excelente mapeador. Garantido que o sujeito já saiba manipular individualmente os elementos centrais para compor um bom MC, agora é possível passar à etapa de modelagem desse conhecimento. Nesse processo, ocorre o refinamento de conceitos e proposições, adequação da hierarquia, revisão da pergunta focal de modo a preparar um MC mais conciso e fiel a complexidade do conteúdo. Para isso, a carga I aumentará, pois, serão múltiplos elementos sendo manipulados para melhorar o conteúdo. Da mesma forma, a carga E também aumentará, como efeito da técnica sendo usada para algo mais complexo do que uma simples representação. O mapeador que ultrapassar essa barreira de aprendizagem poderá ser considerado um mapeador "muito bom", uma vez que modela conteúdos familiares utilizando uma técnica bem conhecida. O mapeador excelente (nível 3) é aquele que já compreendeu e automatizou em sua memória de trabalho o processo de modelagem por meio dos MCs, tendo sua carga E diminuída. Os recursos cognitivos ficam então disponíveis para lidar com um conteúdo complexo (alta carga I) resultando em MCs com alta qualidade geral, além da estrutura e conteúdo.

Uma última etapa evolutiva do mapeador excelente é se tornar um mapeador profissional, capaz de capturar, organizar, representar e modelar o conhecimento de outros especialistas por meio do processo de elicitação (Hoffman *et al.*, 1995, 2006). Esse nível de especialidade na técnica de mapeamento conceitual só é possível pois a manipulação da técnica está totalmente automatizada para o mapeador, sendo recuperada para a memória de trabalho com baixo investimento de recursos cognitivos. Os recursos que sobram são inteiramente dedicados para lidar com a alta carga I imposta pela representação e modelagem de um conteúdo fora do seu domínio de conhecimento. O uso efetivo de MCs em sessões de elicitação vem permitindo a preservação e compartilhamento de conhecimento tácito e especializado (Moon *et al.*, 2011). Vale ressaltar que nem todos os sujeitos interessados nos MCs desejam se tornar mapeadores excelentes ou profissionais. Na maioria dos casos, se tornar bons mapeadores já é suficiente para muitos objetivos educacionais ou profissionais.

4 Protótipo de treinamento em duas etapas orientado à certificação de mapeadores excelentes

A Figura 4 apresenta o protótipo de treinamento em duas etapas orientado à certificação de mapeadores excelentes. A Tabela 3 caracteriza e diferencia as duas etapas sequenciais de treinamento. A primeira etapa diz respeito a atividades *online*, mediadas por computador, estruturadas em três módulos que lidam com os elementos centrais, nessa ordem: conceitos/proposição, hierarquia e pergunta focal. Em cada módulo estão previstos instruções, exercícios e uma avaliação sobre os conteúdos discutidos. Os conteúdos instrucionais são apresentados por meio de recursos áudio-visuais (vídeo-aula, capturas de tela, mesas digitalizadoras, áudios explicativos). Os exercícios permitem a prática de cada informação aprendida na fase de instrução, optando-se por formatos com itens fechados (múltipla escolha, preencha a lacuna, resposta única). O desempenho do usuário nesses exercícios permite gerar *feedbacks* precisos durante o processo de aprendizagem, mesmo que o número de usuários seja elevado. Além disso, a automatização e personalização dos *feedbacks* permite que ele revisite instruções e realize exercícios extras necessários à plena aprendizagem da técnica. O avanço na etapa *online* é controlado pelo desempenho obtido nas avaliações modulares (índice de acertos ≥70%), que funcionam como pontos de regulação do processo de aprendizagem. Ao final do módulo 1 o usuário é convidado a elaborar um MC, a ser revisado continuamente ao final dos módulos 2 (revisão 1) e 3 (revisão 2), potencializando momentos de reflexão metacognitiva. A intenção é que ele demonstre sua habilidade em incorporar novas informações ao seu próprio MC, melhorando a qualidade de estrutura gráfica e a precisão do conteúdo. O propósito desse curso é capacitar novatos a bons mapeadores desenvolvendo habilidades descritas na diagonal da Tabela 2 para organização e representação do conhecimento com MCs. Um desempenho satisfatório na avaliação final do curso (≥ 70%) resulta na certificação do usuário como "bom mapeador" (nível 2).

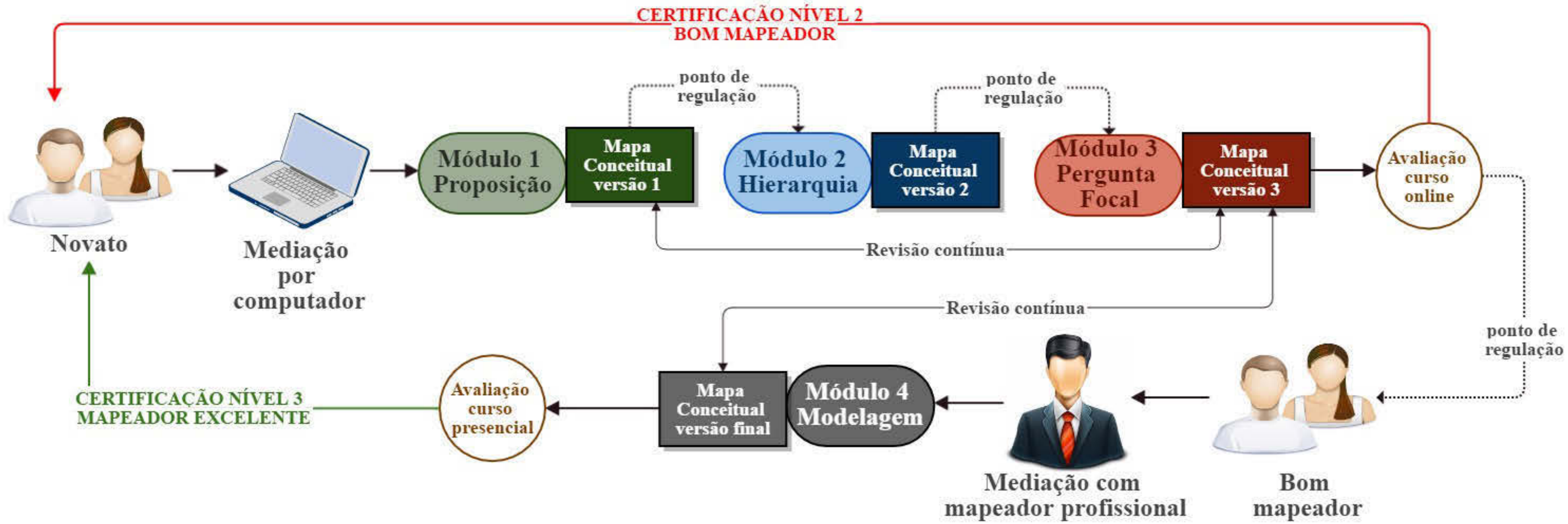

Figura 4. Estrutura geral do treinamento sequencial proposto nesse trabalho. Um curso à distância composto de três módulos (1, 2, 3) objetiva capacitar (em larga escala) novatos na organização e representação de conhecimento por meio dos MCs, levando-os a bons mapeadores. Um curso presencial composto de um módulo (4) objetiva capacitar (sob demanda) bons mapeadores na modelagem de conhecimento por meio dos MCs, levando-os a mapeadores excelentes. O cumprimento de ambas as etapas de treinamento culmina na certificação do usuário em nível 2 e 3.

A segunda etapa diz respeito a atividades presenciais, mediadas por uma equipe de mapeadores experientes, estruturadas em um módulo que lida com a modelagem do conhecimento por meio dos MCs. Apenas bons mapeadores certificados podem participar dessa etapa do treinamento, diminuindo a demanda por esse tipo de atividade. Nesse módulo, instruções e exercícios são oferecidos para que o usuário possa refinar e revisar o MC produzido ao final da etapa *online*, alterando, para isso, pergunta focal, hierarquia, conceitos e proposições. Discussões focadas na modelagem do conteúdo utilizando MCs e *feedbacks* presenciais e personalizados durante o processo de aprendizagem devem garantir o desenvolvimento das habilidades descritas na Tabela 2. A revisão contínua será utilizada para refinar o conteúdo do MC produzido no módulo anterior, permitindo avaliar presencialmente o processo de modelagem feito pelo usuário. Uma das atividades previstas na avaliação final é a produção de um MC, que ao apresentar uma excelente qualidade geral, de estrutura e conteúdo, resulta na certificação como "mapeador excelente" (nível 3).

	Primeira etapa	**Segunda etapa**
Extensão	Larga escala Alto número de usuários atendidos ao mesmo tempo	Sob demanda Apenas bons mapeadores, poucos usuários atendidos por vez
Design	À distância com atividades assíncronas	Presencial
Mediação	Por computador	Com mapeador experiente
Estrutura		
Geral	3 módulos: proposição, hierarquia e pergunta focal, nessa ordem	1 módulo: modelagem
Instrução	Recursos áudio-visuais	Material impresso
Exercícios	Itens fechados	Discussões, práticas, argumentações
Feedback	Automatizado e personalizado	Presencial e personalizado
Elaboração de MCs	Ao final de cada módulo	Durante todo o módulo (refinamento)
Avaliação		
Por módulo	Ponto de regulação – pré-requisito para próximo módulo	Não há
Final	União de atividades dos 3 módulos	Atividades que incluem processo de modelagem com MCs
Desempenho satisfatório	Índice de acertos ≥70%	MC com maior qualidade que o anterior
Papel da revisão contínua	Incorporar os elementos centrais de modo unitário	Refinar o MC a partir da combinação de múltiplos elementos centrais
Habilidades desenvolvidas	Organização e representação do conhecimento	Refinamento e modelagem do conhecimento
Proficiência atingida (certificação)	Bom mapeador (nível 2)	Mapeador excelente (nível 3)

Tabela 3: Detalhamento das características do treinamento em duas etapas orientado à certificação de mapeadores excelentes.

5 Conclusão

Nesse trabalho, defendemos um treinamento em duas etapas sequenciais, organizadas em função dos processos cognitivos demandados. Na etapa *online*, o novato precisa cumprir objetivos de baixa ordem cognitiva (lembrar, entender, aplicar) para organizar e representar seu conhecimento por meio dos MCs. Na etapa presencial, o bom mapeador precisa cumprir objetivos de alta ordem cognitiva (analisar, avaliar e criar) para modelar seu conhecimento por meio dos MCs, se tornardo um mapeador excelente. O protótipo de treinamento em duas etapas permite massificar o bom uso da técnica, ao mesmo tempo que prevê aprofudamento para os interessados em se tornar mapeadores excelentes. O atual momento das pesquisas sobre a técnica de mapeamento conceitual é compatível com a proposta de certificação de mapeadores, tendo em vista (i) a quantidade de usuários de programas como o CmapTools (Cañas et al, 2004) e (ii) a maturidade dos pesquisadores que compõem a comunidade internacional de mapeadores. A aplicação dessa proposta e a busca por uma certificação institucional são os próximos passos para a utilização madura dessa técnica de representação e gestão do conhecimento.

6 Agradecimentos

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USING CONCEPT MAPPING TO COMPARE INTENTIONALLY TAUGHT OUTCOMES WITH ACTUAL OUTCOMES OF A PREKINDERGARTEN ROBOTICS AND PROBLEM SOLVING CURRICULUM

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Abstract: The purpose of this paper is to share knowledge gained using a comparison of a master concept map of lessons in which the children participated to concept maps created from children's interviews asking about their learning during the lessons. The lessons were part of the Robotics and Programming for Prekindergarten (RAPP) project, designed to teach 4- and 5-year old children about robotics, programming, and problem solving. The RAPP implementation that is reported in this paper occurred in five classrooms located in two childcare centers. One piece of the evaluation of the project was interviewing children near the beginning and end of implementation to assess their knowledge of both robotics and problem solving. Researchers transcribed the interviews and created concept maps from each transcription. These interview concept maps were compared to a master concept map of RAPP instruction. Comparisons showed that the teachers used the robot with their children independently of RAPP researchers and introduced some concepts earlier than the researchers. Comparisons demonstrated areas of strength in the lessons (vocabulary cards and songs), and identified areas which needed improvement (last two steps of the problem solving process). Researchers will use the findings to strengthen the RAPP curriculum, and will continue using this process of using concept maps to compare what we are teaching to what children are actually learning in future research projects.

1 Introduction

The purpose of this paper is to report on the use of the concept maps formed from transcriptions of children's interviews to document student learning from the first three lessons of the Robotics and Programming for Prekindergarten (RAPP) project. A comparison is made between the maps of the children's interviews and the master concept map of the first three lessons of the RAPP curriculum. RAPP is a series of instructional lessons designed to introduce 4- to 5-year-old children to robotics, programming, and problem solving. As part of the evaluation of the project, the children were interviewed both near the beginning and again at the end of implementation to assess knowledge gained during the lessons. RAPP researchers concept mapped the interview transcripts. The focus of this paper is the first round of interviews which occurred after the first three RAPP lessons. As the paper is about a robotics, programming, and problem solving curriculum, we first more fully describe RAPP and the rationale for developing engineering lessons for prekindergarten children.

1.1 Prekindergarten Robotics, Programming, and Problem Solving

Because many jobs require proficiency in science, technology, engineering, and mathematics (STEM) skills, the National Science Board advised President Obama in 2009 to make STEM education a priority in early childhood education (National Science Board, 2009). Promoting science in prekindergarten prepares children for later science learning and is a developmentally appropriate practice that builds upon young children's natural desire to explore new things (Bers, 2008). However, children's natural curiosity concerning technology and engineering are rarely nurtured in prekindergarten classrooms. Furthermore, the introduction of engineering and programming coupled with the use of robots helps children learn about abstract mathematics and science concepts in concrete ways and promotes the development of children's technological fluency (Cejka, Rogers, & Portsmore, 2006; Rogers & Portsmore, 2004; Weyth, 2008). Children as young as 4-years old can understand programming rules and create commands for robots to follow. While promoting children's engineering skills, programming also strengthens many foundational concepts including patterning, sequencing, modularity, and the understanding of cause-and-effect relationships.

The purpose of RAPP was to develop and implement innovative STEM lessons for children in prekindergarten classrooms. After reviewing commercially available robots designed for use with young children, the RAPP research team selected KIBO for this project. KIBO is a robot developed at DevTech, Tufts University (Boston, Massachusetts, USA) and commercially available at KinderLab. KIBO is interactive, designed specifically for use with 4- to 7-year old children, and uses programming blocks containing words for readers, pictures for nonreaders, and bar codes. After building their programs with the blocks, children can u the program using KIBO's embedded scanner so that no screen time is required. Three RAPP researchers designed and implemented 12 robotics and programming lessons introducing children to engineering, programming, and problem solving using the KIBO robot. The pilot was implemented over a 3-month period in the participating classrooms and concluded with a concept-map-assisted review of the lessons. Figure 1 presents an overview of the RAPP project. (See McLemore & Wehry, 2016 for more complete RAPP details and results from other evaluations.)

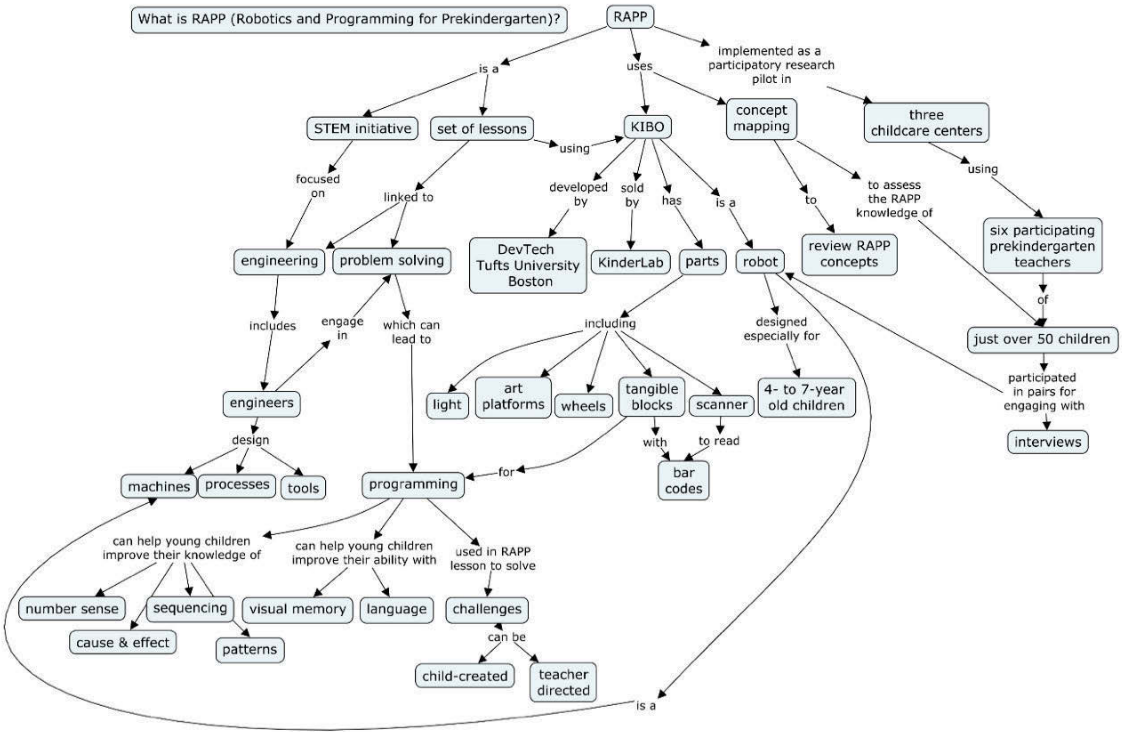

Figure 1: An overview of the robotics and programming project.

2 Participants, Data, and Methodology

2.1 Participants

The RAPP pilot project involved developing, iteratively refining, and evaluating RAPP using a partnership between a university research team and six experienced prekindergarten teachers from three childcare centers located in an American urban area. All three childcare centers enrolled children from low-income families. All of the teachers were women, and five of the six teachers were Black and the other was Asian. In this area, the typical non-public-school-based childcare center teacher has no more than an Associate's Degree. During February 2016, the teachers attended a 3-hour professional development workshop designed to teach about KIBO and programming. Each attending teacher received a KIBO kit to use in her classroom.

2.2 Data

One of the elements of the overall RAPP evaluation plan called for interviewing young children near the beginning and at the end of the project implementation. This paper is focused on the first set of interviews and the children from only two of the childcare centers, the five participating teachers, and the two researchers that worked with the teachers at these two childcare centers. The children at the remaining childcare center had participated in more than three lessons at the time they were first interviewed. The remainder of this section provides information about the RAPP interviews of the young children.

Roberts-Holmes (2014) suggested that young children can feel uncomfortable in one-to-one interviews when the interviewer is not very familiar to them. One way to make young children comfortable is to interview them in groups. Roberts-Holmes also stated that children enjoy the social aspect of the focus-group setting, are more relaxed, and encourage each other in articulating their thoughts. Based on these thoughts, each researcher interviewed the children that she taught.

The research team scheduled the first interviews during the first full week of March, after completing three lessons, to provide time for the children to become familiar with the researcher. We chose to interview two children at a time to accommodate the large number of children participating in RAPP lessons and to encourage less talkative children. When interacting with KIBO during the lessons, the children worked in pairs. The research team decided that pairing them for the interviews was an efficient and logical choice. Two focal questions shaped the interviews: What do you know about KIBO? What do you know about problem solving? Visual aids used during the interviews included the KIBO vocabulary card for the first question and the Solve It 4 (CSEFEL, 2013) poster for the second question (Figure 2). The children's interviews were transcribed and concept mapped.

Figure 2: The Solve It 4 poster.

Concept mapping is documented as a strategy for examining children's understanding of relationships among concepts (Novak & Gowin, 1984). Researchers at the Institute of Human and Machine Cognition summarized the uses of concept mapping in educational settings to include support for learning, assessment of learning, and for the organization and presentation of knowledge. Assessment applications of concept mapping included formative and summative assessments and to document changes in children's conceptual knowledge (Coffey et al, 2003). Many researchers have used concept maps to assess young children's knowledge (Cassata-Wildera, 2008; Monroe-Ossi, Wehry, Algina, & Hunter, 2008; Novak & Cañas, 2006).

RAPP researchers provided non-verbatim transcriptions of the interviews and concept mapped the transcripts. Final data included one master concept map depicting the learning objectives and activities of the first three RAPP lessons, Figure 3, and 30 concept maps from the children's interviews in the five classes.

2.3 Methodology

We visually compared the 30 concept maps to the master concept map in Figure 3. Points of comparisons involved the concepts linked to KIBO: has wheels, motor, scanner, brain; can move; and is held like a sandwich. Comparisons for problem solving came from the Solve It 4 and minimally included ask, think, try, and share. Concept maps that included those concepts indicated that the children could express in the interviews what the researchers' lessons included. However, all five teachers had KIBO kits and had attended the workshop on how to work with KIBO. Thus, teachers had opportunities to use KIBO with their students independently of the researchers. In fact, at one the childcare centers, all three teachers did not have the opportunity to see the researcher work with their children, while at the other childcare center, the teachers did have the opportunity to see the researcher work with their children. So some teachers were observing and extending RAPP lessons while others were working with KIBO totally on their own. Our assumption was that concepts beyond those presented in Figure 3 were the result of the prekindergarten teachers working with KIBO during their instructional time.

3 Results

The results of comparing the master concept map to the 30 interview maps are shown in Table 1. Four indicators are presented: The number of the children's interviews that indicated a teacher effect, the number of children who did not express all four of the Solve It 4 steps, the number of children who did not mention either scanning or scan, and a list of concepts that the class collectively expressed that could be attributed to the teacher rather than the researcher.

As can be seen, some of the children in all of the classes indicated that their RAPP knowledge was augmented by their classroom teacher. Knowledge of the Solve It 4 indicated that over half of the children in all classes could not name the four steps in the cycle even when the pictures on the poster in Figure 2 were available. The try step was the most frequently missing piece across the interviews when children spoke about the cycle. Some of the children did not talk about any of the steps and gave examples of problem solving instead. Likewise, with the exception of one class, at least 50% of the children did not express anything relative to KIBO about scanning. In one class, none of the children mentioned either scan or scanner. The list of new concepts, for the most part is a list of the functions of the programming blocks and the mechanisms that are visible when executing a program.

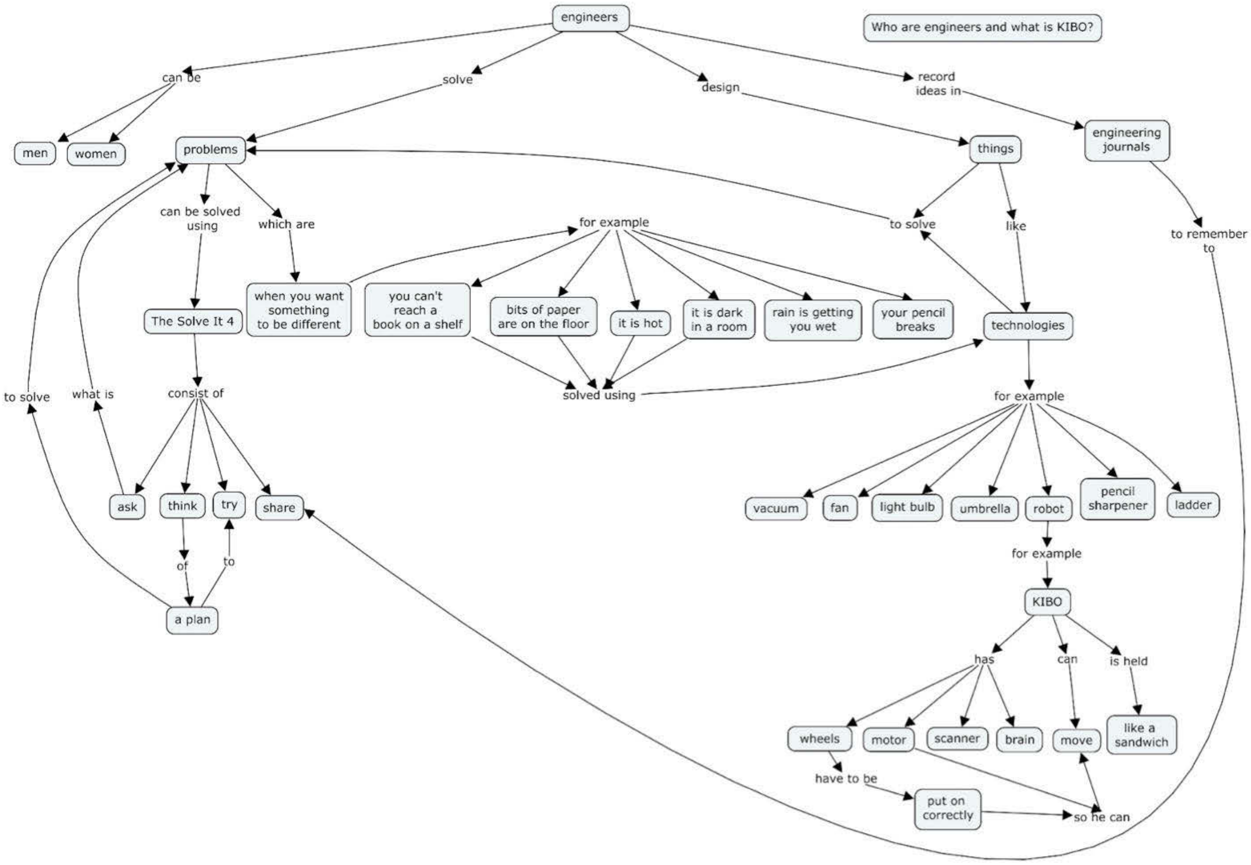

Figure 3: Master concept map of the first three RAPP lessons.

The concept maps in Figures 4-6 represent the variations in the children's interviews. The concept map in Figure 4 is as close as any to the minimal representation in Figure 3. The concept map in Figure 5 is the most expansive of the children's interviews about KIBO, and the concept map in Figure 6 is very representative of expansive concept maps of knowledge of problem solving.

The concept map in Figure 4 is representative of the children who minimally expressed the concepts of the first three RAPP lessons. The concepts with white backgrounds indicate that they are concepts in Figure 3, but not expressed by the children. None of the children's concept mapped interviews indicated the exact minimal concepts. If they knew more than what is on this concept map, they generally spoke using a lot more KIBO vocabulary and added examples of problems to solve or voiced problem solving as a cycle.

The concept map presented in Figure 5 is from an interview in which the children expresssed some of the vocabulary of the KIBO programming blocks. In three instances, the children could add a level beyond the first level, and they did add cross links including one that presents a causation. The children knew that KIBO has blocks (programming) to scan, but did not connect the *blocks* in the second level of the map to their corresponding functions in the first level (*sing*, *beep*, *spin*, play notes, and *go straight*).

Teacher	Summary of Concepts
C1T1 (7)	7 indicated concepts that are not from first three RAPP lessons 4 missed at least one step of the Solve It 4 cycle 3 did not say scanner or scan New concepts: has light, programming blocks (beginning and end) to tell it what to do, button to push to move, and sensor; can sing, play notes, beep, go straight, decorate, scans bar codes, spins & we take care of KIBO
C1T2 (7)	7 indicated concepts that are not from first three RAPP lessons 5 missed at least one step of the Solve It 4 cycle 4 did not say scanner or scan New concepts: has an ear to listen, a telescope, lightbulbs (3 that can come on), programming blocks (yellow, blue, & red: begin, left, right) and button to push to move; and can go straight, shake, decorate, and spin
C2T1 (5)	4 indicated concepts that are not from first three RAPP lessons 5 missed at least one step of the Solve It 4 cycle (*try* missing) 4 did not say scanner or scan New concepts: has chip, a light, and can push nose to move and can scan
C2T2 (6)	4 indicated concepts that are not from first three RAPP lessons 5 missed at least one step of the Solve It 4 cycle (*try* missing) 5 did not say scanner or scan New concepts: can go straight & turn, can spin & go in a circle, has blocks, can shake
C2T3 (5)	4 indicated concepts that are not from first three RAPP lessons 3 missed at least one step of the Solve It 4 cycle (*try* missing) 5 did not say scanner or scan New concepts: can sing, light, spin, shake, stop, & go

Note. Teacher C1T1 is teacher 1 at childcare center 1 and the number in parenthesis after C1T1 indicates the number of interviews from the class. Similarly, C2T2 is teacher 2 from childcare center 2.

Table 1: Results of Comparing the Children's Concept Maps and the Master Concept Map of the First Three Lessons

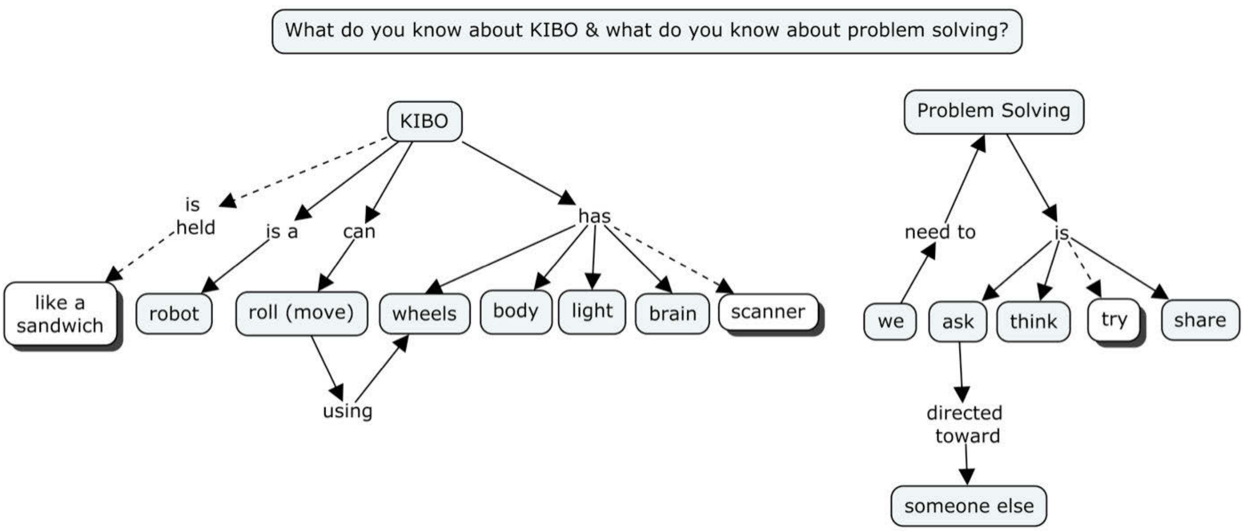

Figure 4: Concept map from an interview that almost replicates the minimally expressed concepts of the first three RAPP lessons.

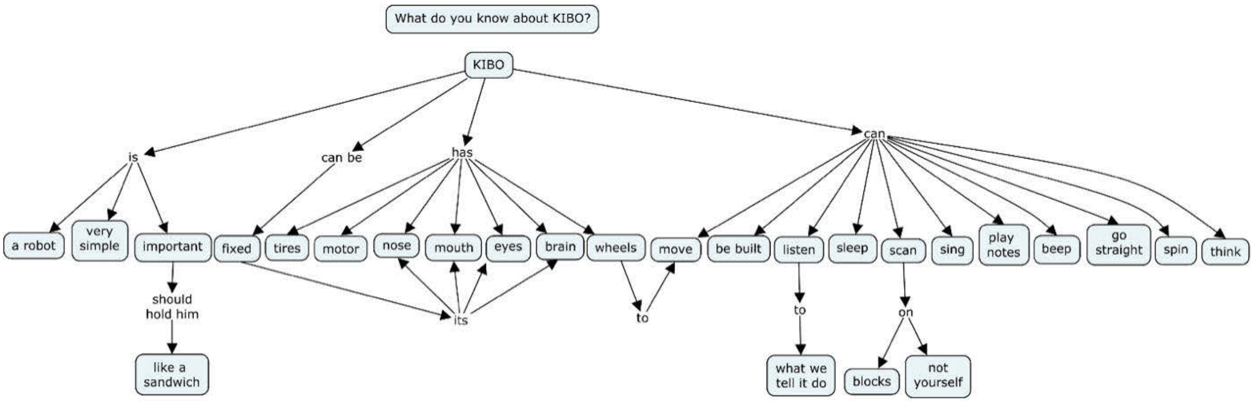

Figure 5: Concept map from an interview that greatly expands the KIBO concepts presented in the first three RAPP lessons.

The concept map presented in Figure 6 is from an interview in which the children speak of problem solving as a cycle. The children expressed all four steps of the Solve It 4 process as a cycle using an if-then statement and *try again*. They also identified *share* as talking rather than sharing toys and playing nice. The interview further connected problem solving to engineering and provided an example of a problem to solve from the lessons.

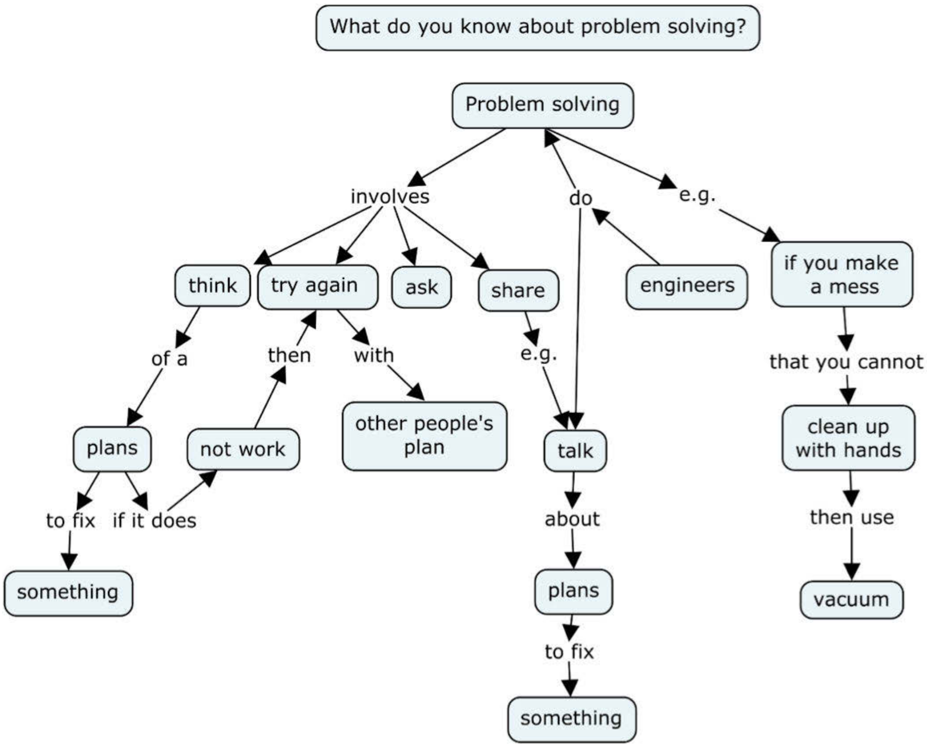

Figure 6: Concept map from an interview that exceeds the minimally stated problem solving concepts presented in the first three RAPP lessons.

4 Discussion

Comparing the concept maps of the children's interviews to the master concept map of the first three lessons documented that all five of the prekindergarten teachers were using KIBO in their classrooms independently of the researchers. The researchers did not have the opportunity to actually observe this, but knew through conversations with the teachers that this use of KIBO was happening. We believe that the information that the children discussed during their first interviews that had not yet been taught was the result of the teachers working with KIBO in their classrooms independently of the researchers. The lists of new concepts children named in the interviews presented in Table 1 suggest that the teachers had introduced many possibilities of KIBO and did so sufficiently enough for the children to voice this knowledge in their interviews. Thus, comparing the set of children's concept maps to the master concept map provided insight into how the teachers were allowing the children to interact with KIBO in addition to what was happening in the researcher-led lessons. Based upon the information that the children shared during the interviews that had not yet been taught during the RAPP lessons, the research team concluded that the teachers were adding value to the project.

The concept map comparisons also identify areas where the children either could not express or were uncomfortable expressing knowledge of KIBO or problem solving or both. Though children were taught the four steps of the solving problem process using a song during the first three lessons, they had only been introduced to the first two steps of the process using vocabulary cards and instructional activities and discussions. Therefore, we were not surprised that several children missed naming the final two steps during the initial interview. The research team was also not surprised that the children's knowledge of problem solving was not solid. Problem solving is a very abstract concept and young children are more comfortable talking about concrete ideas. To help children remember and connect to the abstract information about problem solving presented in the curriculum, the RAPP team developed the Solve It 4 poster, songs, and concrete examples from the children's daily lives. The children quickly learned the songs and sang them throughout the day, even when they were not engaged in RAPP activities. The teachers commented on how often students referred to the problem solving process that they learned with KIBO to solve problems on the playground and during learning center time.

In future implementations, the Solve It 4 poster will be revised relative to *try* and *share*. The picture used for try is of a child putting together three KIBO programming blocks to form a program. The children had not used programming blocks in class by the third lesson, so the picture was not a helpful visual reminder at this early stage in the project. Additionally, prekindergarten children typically understand the meaning of the word *share* as sharing toys with the other children. Teacher's comments usually center on having nice hands and taking turns so the research team plans to add more discussion of this concept. When using the term *share* in RAPP lessons, the children need to know that thoughts can also be shared by talking, drawing, and writing about them.

The findings from this project will be used to refine the RAPP lessons. The researchers did not expect the children to express so much of the new vocabulary and concepts in the lessons. The design of the RAPP lessons allows the new vocabulary to continually build and reinforces the concepts. All concepts have associated vocabulary cards for the children to use. A vocabulary card used in the first lesson is the engineer card pictured in Figure 7. The team plans to assure that vocabulary words are continually used and reviewed throughout the lessons to assure they are learned.

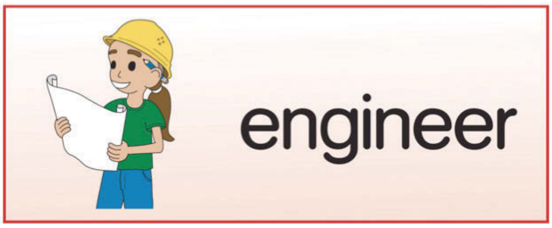

Figure 7: The engineer vocabulary card.

Pairing the children for the interviews most likely made them more comfortable, while also providing security for them to try out their newly minted knowledge. In the interviews, the children were obviously reacting and amplifying what each other were saying.

An area for future research is to use this process of concept mapping lessons and comparing them to children's interview concept maps more frequently to monitor and revise our instructional plan as we continue to build a 6-month curriculum. However, interviewing children, even in pairs, is very time intensive due to the need to transcribe the interviews and to then concept map the transcripts. For this purpose, perhaps a random sample of pairs to interview would be sufficient.

5 Acknowledgement

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VIDEOJUEGOS DISEÑADOS CON MAPAS CONCEPTUALES PARA APRENDER A PENSAR

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Abstract. This study pursed to use concept mapping to design videogames for learning and thinking. Concept maps were created for concept meaning and curricular content to design and use of a videogame. Preliminary results are presented and discussed. The study contributes to a methodological change in concept learning through video gaming based on concept mapping, and thus making learning more active, interactive, constructive and meaningful.

1 Introducción

Este trabajo aborda un problema que se ha evidenciado en la educación de nuestro país, Chile, principalmente en los últimos años, a partir de los resultados obtenidos en distintas pruebas escolares estandarizadas, como es el bajo nivel de logros de aprendizaje y habilidades de pensamiento que presentan los estudiantes chilenos.

Si bien es sabido que los resultados obtenidos en distintos sectores curriculares se relacionan con variables como situación socioeconómica, formación de los profesores, clima escolar, entre otros, numerosos estudios han dado cuenta de la centralidad que tiene la práctica pedagógica y la interacción en el aula sobre dichos logros.

Es sabido que "la práctica pedagógica es el resultado de una compleja articulación e interrelación entre la comunicación profesor-alumno, la orientación hacia el aprendizaje que dicha comunicación tenga, el tipo de conocimientos y capacidades que están siendo puestas en juego, el uso de recursos de información y trabajo (como son los materiales educativos, los textos y los computadores, por ejemplo), y las reglas de evaluación que se apliquen" (Román, 2003, p. 116). Se debe considerar entonces que "en el reducido espacio de una sala de clases y a través de la interacción social y pedagógica que ahí ocurre, se instala una cultura pedagógica y educativa que permite o limita la construcción de los aprendizajes, la incorporación de la experiencia de lo cotidiano de los sujetos, la utilidad de lo tratado y la significación de lo aprendido" (Román, 2003, p. 118). En este sentido resulta vital proponer y promover un sistema de enseñanza-aprendizaje que sea eficaz, estimulante para estudiantes y profesores, y que sobretodo garantice calidad y consonancia con la reforma curricular y con los actuales programas implementados para el mejoramiento de los procesos educativos.

En la actualidad existe un creciente consenso sobre la importancia del cambio en las prácticas docentes para mejorar la calidad y equidad de la educación, destacándose este cambio, como uno de los factores más importantes para su logro. El estudio realizado por Barber y Mourshed (2007), por ejemplo, destaca las prácticas de los profesores como uno de los factores más importantes para explicar el éxito de los mejores sistemas educativos del mundo. Por otro lado, los estudios sobre innovación en educación tienden a poner al centro la idea de que la innovación debe estar orientada por el esfuerzo de mejoramiento continuo de procesos y resultados. Por ejemplo, el estudio SITES M2 vincula la innovación de las prácticas docentes usando TICs con resultados en el aprendizaje de los alumnos y profesores (Kozma, 2003).

En este sentido surge la necesidad de desarrollar un enfoque en el cual se preste atención sustancial al proceso de aprendizaje, bajo la idea de que es tan importante lo que se aprende como el modo en que se aprende. Resulta necesario orientar a los estudiantes en el proceso de aprendizaje (cómo aprender) para que sean capaces de aprender por sí mismos (aprender a aprender y aprender a pensar) (Monereo, 1990). De esta forma será posible abandonar los aprendizajes reproductivos y conseguir aprendizajes significativos, los cuales pueden ser favorecidos con la integración curricular de las TICs, entendida como el proceso de hacerlas parte del curriculum, permeándolos con los principios educativos y la didáctica que conforman el engranaje del aprender (Sánchez, 2003). En este sentido, el aprendizaje en ambientes enriquecidos con tecnología no puede entenderse como una mera transposición del contenido externo a la mente del estudiante, sino como un proceso de (re) construcción personal de ese contenido que se realiza en función, y a partir, de un amplio conjunto de elementos que conforman la estructura cognitiva del aprendiz: capacidades cognitivas básicas, conocimiento específico de dominio, estrategias de aprendizaje, capacidades metacognitivas y de autorregulación, factores afectivos, motivaciones y metas, representaciones mutuas y expectativas (García & Perera, 2004).

A partir de lo que se ha planteado, creemos que nuestra propuesta se acerca al problema desde una perspectiva renovadora, que no sólo pone énfasis en los contenidos a tratar y en los recursos tecnológicos a utilizar, sino que además incorpora la aplicación de prácticas pedagógicas y estrategias de enseñanza-aprendizaje que estimularán y potenciarán el desarrollo de habilidades de pensamiento, promoviendo la autonomía de los estudiantes, el autoaprendizaje y la construcción de aprendizajes en equipo, la cooperación entre los diferentes actores participantes, complementando los planes, programas y actuales principios que sustentan el ajuste curricular y los mapas de progreso.

El propósito principal de esta investigación fue analizar la contribución al desarrollo de habilidades de pensamiento crítico de estudiantes de NB5 y NB6 de Educación Básica y NM1 de Educación Media a través de la interacción con videojuegos basados en mapas conceptuales.

2 Trabajo Relacionado

2.1 Integración Curricular TICs

Integrar curricularmente las TICs significa utilizarlas como herramientas para estimular el aprender de un contenido específico en algunas de las diferentes áreas curriculares o en un contexto multidisciplinario (Sánchez, 2003). La integración curricular de las TICs busca hacer una contribución específica al aprendizaje, ofreciendo metodologías, recursos y contextos de aprendizaje que pueden resultar más difíciles de implementar a través de otros medios (Sánchez, 2001). Una efectiva integración de las TICs se logra cuando la tecnología llega a ser parte integral del funcionamiento de la clase y resulta ser tan asequible como otras herramientas utilizadas para aprender, todo ello en forma natural, "invisible" (Sánchez, 2001, 2003).

Las TICs resultan un aporte en distintas facetas del proceso de enseñanza-aprendizaje. En primer lugar, favorecen el principio pedagógico que prioriza por sobre los contenidos a las competencias. Las metas esenciales son las competencias y los contenidos para adquirir dichas competencias (Balanskat, Blamire, & Kefala, 2006). En segundo lugar, las TICs incluyen la necesidad de realizar una planificación, de este modo cuando el docente decide integrar curricularmente las TICs a su práctica pedagógica, necesariamente deberá aprender a planificar: preguntarse qué aprendizajes quiere potenciar, con qué recursos, cuál es la mejor estrategia para trabajarla en el aula (Dwyer, Ringstaff, & Sandholtz, 1991; Sánchez, 2001; Sánchez, Salinas, Purcell, & Pérez, 2009). Estas preguntas son esenciales para la autonomía, para aprender a aprender y apropiarse de las TICs, y de no llevarse a cabo pueden conducir a un uso de carácter negativo, dado que se perderán oportunidades para realizar actividades que resulten más significativas y beneficiosas para los aprendices (Sánchez, 2001).

2.2 Videojuegos y Educación

El uso de videojuegos en educación tiene variadas formas de ser aplicado. En particular, se hace énfasis en que los videojuegos impactan en el desarrollo de habilidades de resolución de problemas, ya que luego de jugarlos, los aprendices mejoran sus estrategias para enfrentar un problema (Klopfer & Yoon, 2005; Sánchez, 2007). Algunos estudios plantean que los juegos pueden promover aprendizaje de alto orden (Steinkuehler, 2008), como también incrementar el diálogo entre los alumnos (McDonald & Hannafin, 2003). Otros estudios describen los aspectos significativos que tienen los videojuegos en las habilidades sociales (Pellegrini, Blatchford & Kentaro, 2004) y culturales (Cipolla-Ficarra, 2007) de los alumnos.

Los videojuegos también producen una alta motivación y compromiso en los alumnos, aspectos fundamentales que ayudan a mejorar su compromiso con las actividades de aprendizaje (Sánchez, 2008; Sánchez, 2007; Klopfer & Yoon, 2005). En el trabajo de Kelly y colaboradores (2007) se presenta un videojuego educativo o serious game tipo shooter para el aprendizaje de la ciencia y se señalan tres aspectos claves en el proceso de diseño. Estos aspectos son: (A) El diseño del juego, en el que debe quedar clara la estrategia de juego y los contenidos; (B) Integración del videojuego, correspondiente a la forma de presentar los contenidos y la interacción de los diversos elementos del videojuego; y (C) Proveer de múltiples escalas para construir las simulaciones y visualizaciones de los procesos presentes en el videojuego. Los autores ponen énfasis en que el trabajo entre los diseñadores del videojuego y los revisores de contenido no es algo fácil de lograr, pero es primordial para el éxito de un videojuego educativo.

Ahora bien, no basta con sólo generar videojuegos educativos, sino que se debe adoptar una metodología pedagógica nueva (o ad-hoc) en torno a la forma de aprendizaje en la escuela (Kickmeier-Rust et al., 2007; Squire, 2005). Squire (2005) plantea cinco aspectos primordiales a este respecto: 1. Enfocar los contenidos a aspectos más transversales y menos específicos, de modo tal que los alumnos estudien y comprendan causas y efectos, y los por qué de las cosas. 2. Considerar la heterogeneidad del grupo curso en cuanto a intereses, habilidades y capacidades para aprender. 3. Acomodar los horarios para que un aprendiz interesado en un tema pueda profundizar en él. Se pueden ocupar otros tiempos fuera de la clase para que los alumnos estudien temas concretos. 4. Diversificar los medios para transmitir el conocimiento, no limitarse a los medios clásicos utilizados por el profesor (libros, películas o presentaciones). Por ejemplo, utilizar videojuegos permite que los aprendices trabajen motivados fuera del horario regular de clases y con otra perspectiva sobre los contenidos. 5. Orientar las evaluaciones como una oportunidad para apoyar el aprendizaje.

Complementando lo que ya se mencionó anteriormente, el uso de las TICs para apoyar la construcción del aprender debe surgir de una necesidad o de un problema del aprender y de cuestiones tales como qué hacen los alumnos cuando construyen su aprender y cómo puede la tecnología ayudar a mejorar o expandir aquello (Sánchez, 2004). Las TICs pueden constituirse en excelentes herramientas para el desarrollo de ciertas habilidades de pensamiento.

2.3 Habilidades de Pensamiento Crítico

Las habilidades de pensamiento son de interés de muchos investigadores en educación, quienes las definen como las capacidades mentales que permiten al individuo construir y organizar su conocimiento para aplicarlo con mayor eficacia en diversas situaciones (Herrnstein, Nickerson, Sánchez & Swets, 1986; Johnson, 2008; Sánchez, 2001). El desarrollo de las habilidades de pensamiento necesita el uso de conocimientos, procedimientos y actitudes (Sánchez, 2002), por lo cual, el desarrollo de estos aspectos conducirá a impulsar el aprendizaje y el pensamiento en los aprendices (Sánchez, 2002). Algunos estudios han focalizado sus evaluaciones en el desarrollo de este tipo de habilidades. Sus resultados demuestran que cuando se aplica una metodología orientada al desarrollo de habilidades de pensamiento, ésta genera un impacto significativo en los resultados obtenidos por los estudiantes (Herrnstein et al., 1986; Sánchez, 1983a, 1983b).

De acuerdo a Facione (1990, 2007) las habilidades cognitivas centrales del pensamiento crítico son: interpretación, análisis, evaluación, explicación, inferencia y auto-regulación o metacognición. Una de las técnicas utilizadas para el desarrollo del pensamiento crítico es el mapa conceptual. Esta técnica ha sido utilizada en la enseñanza de distintas áreas del conocimiento: enfermería (e.g. Vacek, 2009; Wheeler & Collins, 2003), ciencia (e.g. AlRaway, 2004; MacKinnon, 2006), matemática (e.g. Afamasaga-Fuata'i, 2008), química (e.g. Markow & Lonning, 1998), entre otras áreas. Los resultados sugieren que los mapas conceptuales son efectivos en promover el desarrollo de habilidades de pensamiento crítico en los estudiantes.

Para nuestro caso, siendo el objetivo "Aprender a Pensar" de las características del pensamiento crítico, nos enfocaremos en tres de ellas, descritos por los autores Engel, Fisher y Ennis, y relacionadas con las habilidades que se buscan desarrollar a través del "Videojuego diseñado con mapas conceptuales para aprender a pensar" Interpretar, Análisis y Evaluación.

2.4 Mapas Conceptuales

En la década de los 70' Novak y su equipo desarrollaron la técnica de los Mapas Conceptuales como "un método para ayudar a estudiantes y educadores a captar el significado de los materiales que se van a aprender" (Novak & Godwin, 1988, p. 19). El objetivo de los mapas conceptuales es "representar relaciones significativas entre conceptos en forma de proposiciones" (Novak & Godwin, 1988, p. 33), de esta forma "presentan un medio de visualizar conceptos y relaciones jerárquicas entre conceptos" (Novak & Godwin, 1988, p. 44). Esta técnica se basa en la teoría cognitiva de asimilación propuesta por David Ausubel (1983), en la cual la adquisición de nuevos conocimientos se produce a través de su asimilación con los previamente adquiridos.

Así, los mapas conceptuales se constituyen en una excelente estrategia didáctica para incrementar y poner en práctica el aprendizaje significativo (Novak & Godwin, 1988; Ramos, 2004), ya que éste "implica la asimilación de nuevos conceptos y proposiciones en las estructuras cognitivas" (Novak, 1991, pp. 216) de los estudiantes. Para permitir esto "los mapas conceptuales deben ser jerárquicos; es decir, los conceptos más generales e inclusivos deben situarse en la parte superior del mapa y los conceptos progresivamente más específicos y menos inclusivos, en la inferior" (Novak & Godwin, 1988, pp. 35). Diseñar un mapa conceptual genera aprendizaje significativo en la medida que el aprendiz entienda, razone y ejecute acciones con el objetivo de conciliar los conceptos previos adquiridos y los nuevos conceptos que está tratando de incorporar (Beirute, 2006).

3 Implementación del Estudio

La metodología de trabajo del estudio consistió en etapas que van desde la generación y desarrollo de los videojuegos editor y motor, hasta las actividades de cierre y de masificación del mismo, en el período de los años 2013 a 2015. En cada una de las etapas intervinieron profesionales de la educación, computación y diseño gráfico, además de los docentes y estudiantes participantes del estudio.

Para realizar el estudio se construyó un set de videojuego que consistió esencialmente en un editor de videojuegos y un videojuego motor.

3.1 Editor de Videojuegos

Es una etapa del videojuego que integra la creación de mapas conceptuales como parte de sus actividades, donde el profesor ingresa un set de conceptos relacionados con el contenido que están aprendiendo y que los estudiantes ocuparán en el editor. Una vez que el profesor ha ingresado los conceptos, los estudiantes se sumergen en un videojuego inspirado en la temática de "Tower Defense" que los desafía a recuperar todos los conceptos para armar el mapa conceptual, terminando así la primera parte del videojuego (Ver Figura 1). La construcción del mapa conceptual y la relación que establezcan entre los conceptos, permitirá pasar a la segunda etapa del videojuego.

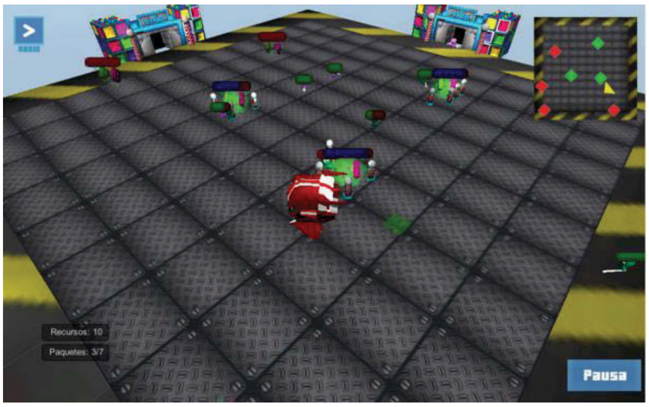

Figura 1: Pantalla de la etapa I, el videojuego Editor. Se observa la plataforma y al centro el personaje principal.

Una vez que los alumnos entregan los mapas conceptuales creados, el profesor recurre a la plataforma web que le permite evaluar, según la rúbrica entregada y los criterios definidos en ella, el trabajo desarrollado por sus estudiantes (Ver Figura 2). Esta evaluación determina el permiso para hacer utilización del videojuego motor y el nivel de dificultad de ejecución que tendrá. Es importante mencionar que la estructura física-espacial, plataformas del videojuego motor, está alimentado en base a la estructura física-espacial de los conceptos dentro del mapa conceptual.

3.2 Videojuego Motor

Es la segunda etapa del videojuego, se diseñó como un motor para plataforma web. El mapa conceptual creado por el estudiante con el videojuego editor define el escenario que desplegará el motor de ejecución de videojuegos. En esta etapa el usuario debe recorrer distintas plataformas donde cada una representa un concepto que usó para confeccionar el mapa conceptual. Las plataformas están conectadas de la misma manera que se conectaron los conceptos en el mapa conceptual.

Para pasar de una plataforma a otra, el usuario debe superar un desafío de habilidad, donde la dificultad está directamente relacionada con la evaluación que el profesor asignó al mapa conceptual creado por el alumno. Aquél estudiante que construyó un mapa conceptual completo integrando todos los conceptos, podrá recorrer todas las plataformas y la estructura física-espacial del mapa conceptual. En cambio aquel estudiante que diseñó un mapa conceptual deficiente, las plataformas representarán este diseño y no podrá completar todas las etapas puesto que pueden existir errores conceptuales o de relación en el mapa. Es por esto la importancia de la evaluación que el docente realiza al mapa conceptual.

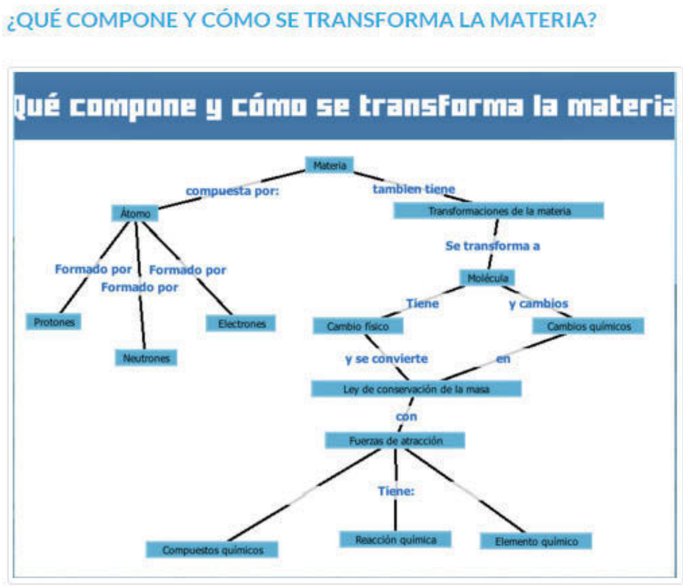

Figura 2: Pantalla del profesor donde se ve el mapa conceptual construido por un estudiante.

Cada plataforma por la que el estudiante salta, desplegará una pregunta, que previamente fue ingresada por el profesor, y que se debe responder para pasar a la siguiente plataforma (Ver Figura 3).

Figura 3: Pantalla de la etapa II, el videojuego Motor. Se observa la plataforma y al centro el personaje principal con la pregunta para responder.

3.3 Usabilidad del Videojuego

Al ser un juego orientado a utilizarse en establecimientos educacionales de manera esporádica, no se espera que sea jugado de manera recurrente por los usuarios, por lo que son de extrema importancia que los modos de interacción del videojuego sean intuitivos, fáciles de aprender y que no generen errores. La facilidad de aprendizaje de la interfaz es un punto clave con respecto a este tema. Al tratarse de un videojuego con fines educativos, la idea es que ayude al aprendizaje de los usuarios y que no se convierta en un elemento nuevo que aprender. También es importante mantener al juego libre de errores y lograr una experiencia lo más satisfactoria posible, pues es importante que el usuario se vea motivado a utilizar el software y aprender los conceptos que el profesor haya preparado para la actividad. La evaluación de usabilidad se realizó con estos conceptos en mente, con el fin de asegurarse que la interfaz sea eficaz, eficiente y satisfactoria para los objetivos que se planea utilizarla.

Para determinar si el videojuego cumple con las características mencionadas, se utilizaron 3 métodos de evaluación de usabilidad:

a) *Observación no participante*: Este método consiste en observar usuarios finales mientras interactúan con el sistema de forma natural en un contexto lo más real posible.
b) *Cuestionario de Usuario Final*: tiene como finalidad recopilar información cuantitativa con respecto a la visión cualitativa que tienen los usuarios finales de la interfaz mediante un cuestionario.
c) *Evaluación Heurística* tiene por objetivo proporcionar un análisis integral del videojuego desde el punto de vista de las Heurísticas de Usabilidad de Jakob Nielsen y las Reglas de Oro de Ben Schneiderman.

4 Metodología

4.1 Diseño de Investigación

El objetivo general de la presente investigación fue analizar el desarrollo de habilidades de pensamiento crítico de estudiantes de Séptimo y Octavo año de Educación Básica y Primer año de Educación Media a través de la interacción con un editor de videojuegos basados en mapas conceptuales.

Para evaluar el estudio y sus resultados se propuso un diseño cuasi-experimental con medición antes/después y grupo control. Se emplearon una combinación de técnicas cualitativas y cuantitativas para la recolección de datos.

4.2 Muestra

El contexto en el que se desarrolla el proyecto que se presenta a continuación se sitúa en tres comunas de la Región Metropolitana, La granja, Lo Prado y Renca, en establecimientos de dependencia municipal, de grupo socioeconómico (GSE) bajo o medio bajo y pertenecientes a los segmento B y C de la clasificación SIMCE (Sistema de Medición de la Calidad de la Educación, Chile).

Participaron 10 profesores en el estudio, profesionales que trabajan en los colegios antes descritos, que realizan clases a Séptimo y Octavo año de Enseñanza Básica y Primer Año de Educación media y que utilizan o han utilizado previamente como metodología en sus clases la construcción de mapas conceptuales. Además, son profesionales interesados en incorporar las TICs en sus clases e innovar en la metodología de enseñanza, independiente del subsector temático en el que realicen clases.

Los estudiantes que participaron fueron de los colegios anteriormente descritos y de los cursos de séptimo, octavo a primero medio. La descripción de las aplicaciones se detalla en la Tabla 1.

Subsector	**Curso**	**Clases**	**Fecha (2015)**
Cs. Naturales	8 básico	1	Mayo
Matemáticas	8 básico	2	Mayo
Historia	1 Medio	2	Mayo
Inglés	1 Medio	2	Mayo
Física	1 Medio	3	Mayo
Lenguaje	1 Medio	2	Mayo

Tabla 1: Detalle de la muestra donde se aplicó el videojuego.

4.3 Instrumentos

El enfoque de la investigación combinó técnicas cualitativas y cuantitativas. Con las técnicas cualitativas analizamos la experiencia con la flexibilidad y profundidad que ellas permiten, recuperando la complejidad de la información. Con las técnicas cuantitativas podremos medir las variables de estudio más importantes, describir su distribución en la población de usuarios incluidos en la muestra y utilizar medidas estadísticas para analizar la asociación y correlación de variables fundamentales.

Los principales instrumentos que se utilizaron fueron:

a) *Pauta de observación de práctica pedagógica*: Pauta de observación de la práctica pedagógica, construido según los indicadores del Marco para la Buena Enseñanza (CPEIP, 2008). De este marco, sólo se han considerado dos dimensiones: Enseñanza para el aprendizaje de todos los estudiantes y Creación de un ambiente propicio para el aprendizaje.

b) *Encuesta de capacitación* (pre y post): Estas encuestas fueron construidas en función a la necesidad del proyecto de evaluar el proceso de capacitación y las concepciones de los docentes sobre los contenidos a trabajar.
c) *Test motivacional* (pre y post): Cuestionario de Estrategias de Motivación para el Aprendizaje, de Pintrich (1991), que contiene dos secciones de las cuales se utilizó solo la primera.
d) *Test de pensamiento crítico* (pre y post): Test de Cornell, Forma X, Habilidades del Pensamiento Crítico, de los autores Ennis, Millman & Tomko (2005). El instrumento se divide en cuatro secciones las cuales evalúan diferentes habilidades relacionadas al pensamiento crítico. Estas son evaluadas por medio de una historia ficticia, en donde los estudiantes deben responder cuál de las afirmaciones responde de mejor manera al ítem. Para términos de la presente investigación sólo se utilizó la primera sección.
e) *Entrevista en profundidad* a estudiantes y docentes: las preguntas de las entrevistas para estudiantes y docentes han sido construidas para recoger información respecto del impacto del videojuego en la motivación de los estudiantes, en su aprendizaje, en la construcción de mapas conceptuales como técnica de estudio y en la práctica pedagógica. Además de evaluar el videojuego, sus características e implementación en el establecimiento.

Los instrumentos utilizados son adaptaciones de otros anteriores, los cuáles fueron revisados y evaluados por un panel de expertos en informática educativa del equipo de Centro de Computación y Comunicación para la Construcción del Conocimiento, C5, de la Universidad de Chile.

5 Resultados

Los resultados de la presente investigación se pueden enmarcar en tres grandes aspectos, sobre la práctica pedagógica de los docentes, la motivación y el desarrollo del pensamiento crítico.

5.1 Prácticas Pedagógicas

La práctica pedagógica es un proceso más amplio que el desempeño en el aula, abarcando las horas lectivas y no lectivas, así como también el conjunto de actividades y condiciones que permiten la materialización de la actividad docente. Para efectos del presente análisis se identifican cuatro aspectos centrales de una adecuada práctica pedagógica: 1) La preparación de una clase con objetivos y metodología definidos; 2) Las coordinaciones necesarias para que se realice la clase; 3) La disposición de infraestructura; y 4) El desarrollo de la clase.

Respecto a la preparación de la clase es posible afirmar que la plataforma virtual provee a los docentes un esquema adecuado de objetivos y una metodología concreta, a saber, la realización de mapas conceptuales por medio del videojuego. No obstante, se identifican dos obstáculos estructurales en esta fase de la práctica pedagógica, por una parte, la escasez de tiempo de los docentes, y por otra, la falta de capacitación de los mismos en las áreas de computación y TICs en general. Si bien ambos obstáculos son inherentes a la práctica pedológica en el contexto actual del sistema educativo chileno, éstos se intensifican al introducir el videojuego con mapas conceptuales en la práctica docente.

En relación a la falta de tiempo, se debe considerar que el uso de la plataforma para la preparación de la clase implica disponer oportunamente de un computador con internet, recurso que no siempre tienen a disposición los profesores durante los tiempos que dedican a la actividad no lectiva. Como señala una docente de historia:

"Va a sonar cliché pero el gran problema que tenemos los profesores es tiempo, entonces si tú vas a hacer un mapa conceptual les llevas las cartulinas, escribes los conceptos en la pizarra y ellos lo trabajan. Acá yo tengo que darme el tiempo de sentarme en la plataforma, de subir la información, clasificar los tipos de preguntas, entonces lo que sería más problema es el tiempo (...) lamentablemente y que no tiene que ver con nosotros, ni tiene que ver con el juego, es un tema país" (Docente de Historia, Colegio Benjamín Subercaseaux).

Si bien los niveles de capacitación de los profesores en las TICs son heterogéneos, la mayoría de ellos reconoce que aún no existe una incorporación sistemática de las tecnologías en la práctica docente y que no se encuentran suficientemente actualizados:

"Yo soy un poco negado para la modernidad, me dejó atrás, trato de hacerlo pero me cuesta" (Docente de Música y Tecnología, Colegio Benjamín Subercaseaux).

Vinculado a la falta de capacitación, existe una preocupación respecto a que se diluya el del rol docente que utiliza las tecnologías, dado que éstos descansarían en la herramienta, tal como señala un profesor de Cs. Naturales:

"He visto muchos profesores que ni siquiera un power (point) para dar una presentación inicial sobre lo que se va a tratar el programa, les dicen ya www.gmail...y nada más, hagan lo que tienen que hacer" (Docente de Cs. Naturales, Colegio Granja Sur).

Otro aspecto frecuentemente invisibilizado de la práctica docente, dice relación con el conjunto de coordinaciones que se deben realizar con los distintos actores de la escuela. En este contexto, la utilización del videojuego implica un esfuerzo adicional por conseguir el laboratorio de computación (especialmente para asignaturas que normalmente no lo utilizan como Lenguaje e Historia) y asegurar el soporte técnico para la correcta implementación de la plataforma:

"Yo creo que la implementación del recurso es el problema actualmente. Las personas que están a cargo de los aparatos tecnológicos no se coordinan con los profesores. Es responsabilidad del profesor introducir las tecnologías, pero muchas veces el profesor se ve limitado en sus decisiones" (Docente de Cs. Naturales, Colegio Granja Sur).

Respecto a los recursos en infraestructura necesarios para la implementación del juego, la gran mayoría de los profesores coincide en que los colegios cuentan con los laboratorios de computación, aunque éstos son insuficientes:

"Ojala tener dos salas de computadores, no una. No sé si el juego funciona en Tablet, porque aquí (en el colegio) compraron Tablet. La sala es muy solicitada para distintos proyectos y tenemos una sala. Electrónica la usa generalmente y les dan prioridad a ellos. También habría que mejorar si o si el tema de la conectividad, tener la cantidad suficiente de notebook o Tablet para evitar que estén dos o tres en un computador, que no es muy adecuado" (Docente de Matemática y Computación, Liceo Granja Sur).

5.2 Motivación

Para dar cuenta de los efectos de la utilización del videojuego en la motivación de los estudiantes es preciso hacer la distinción entre dos posibles interpretaciones de la variable motivación:

- La motivación de los estudiantes respecto al videojuego con mapas conceptuales
- Los efectos de la utilización del videojuego con mapas conceptuales en la motivación de los estudiantes por querer aprender (a mediano y largo plazo).

El primer aspecto fue abordado con la información obtenida a través de las entrevistas en profundidad, mientras que el segundo fue abordado mediante el análisis cuantitativo del test de motivación aplicado a los estudiantes.

En relación a la motivación de los estudiantes con el videojuego existe un consenso entre los docentes respecto a los altos niveles de motivación que mostraron los estudiantes:

"Yo creo que fue provechosa en términos generales (la experiencia de aplicación). Ver también la reacción de los chiquillos que fue positiva, porque se motivaron. Del momento que una sale de la sala de clases ya la actitud es distinta. Y le dieron un buen uso porque no tuvimos ningún problema con los niños que hayan estado haciendo otras actividades aparte del juego" (Docente de Historia, Colegio República de Estados Unidos).

La gran mayoría de los docentes percibe que la motivación de los aprendices se vincula con el carácter lúdico de la herramienta. Sería la idea de "juego" con mapas conceptuales lo que permite captar el interés del estudiante. Cabe señalar que los profesores comparten una percepción negativa sobre los niveles de motivación de los estudiantes en general, señalando que la gran mayoría presenta una muy baja disposición a aprender. En este contexto, la posibilidad de que los aprendices aprendan mientras juegan es un aspecto clave para mejorar su disposición frente a la clase:

“La palabra juego ya cambió la percepción, ahí está la clave” (Docente de Historia, Colegio Benjamín Subercaseaux).

“Ya que tú les digas a los niños vamos a jugar se motivan inmediatamente, si tú les dices vamos a hacer un mapa conceptual en grupo igual se motivan, pero ir a jugar al computador abre su mente para aprender. Porque generalmente pasa que ellos no quieren aprender, no es que no tengan las capacidades, no es que tengan alguna debilidad puntual, es que no quieren (...) y si un niño no quiere aprender nunca va a aprender, entonces ya decirles ‘vamos a ir a jugar’ les abre un poco e igual les va a entrar esa información” (Docente de Historia, Colegio Benjamín Subercaseaux).

Junto con observar un aumento de la disposición de los aprendices al aprendizaje, se identifican cuatro efectos conductuales positivos durante la experiencia de aplicación del videojuego: 1) Aumento de la sociabilidad y cooperación; 2) Mayor disciplina; 3) Aumento de la concentración; y 4) Mayor asistencia.

El aumento de la sociabilidad fue observado en el incremento del diálogo de los aprendices, el cual estuvo centrado tanto en las estrategias de superación de los desafíos del juego como en los contenidos del mapa conceptual:

“La plataforma en sí facilitó el trabajo cooperativo. Por ejemplo, el niño que no sabía utilizar el videojuego, entonces el de al lado le enseñaba. Yo creo que ese recurso propicia actividades que son sumamente en equipo, se socializaba el contenido también” (Docente de Cs. Naturales, Colegio Granja Sur).

No obstante el incremento del diálogo y las conversaciones, los docentes coinciden en que la clase se desarrolló en un clima de disciplina y tranquilidad:

“Estaban más tranquilos (durante la aplicación del videojuego) y eso que el que ese curso es como bien disperso” (Docente de Historia, Colegio República de Estados Unidos).

La falta de concentración es concebida por los docentes como la principal desventaja de realizar actividades en el laboratorio de computación del colegio, en virtud de las dificultades de control respecto al uso que los aprendices realizan de internet. Sin embargo, durante la aplicación del videojuego con mapas conceptuales, los profesores percibieron altos niveles de concentración en la actividad, tal como señala una docente de historia:

“En ese curso cooperaron bastante, porque me ha tocado la experiencia de otras veces ir al laboratorio de computación y los chicos altiro se meten a sus páginas. Y en este caso yo vi que fueron respetuosos en ese aspecto, en el sentido de que esperaron las instrucciones y se enojaban cuando no les resultaba la cosa, es decir, estaban metidos en lo que tenían que hacer, los vi preocupados cuando no les resultaban los mapas” (Docente de Historia, Colegio República de Estados Unidos).

En aquellos cursos en que los aprendices fueron informados previamente de la programación de la actividad, los docentes observan un aumento de la asistencia, la cual atribuyen al interés de los aprendices por participar en la clase con el videojuego:

“Este juego, yo me fije los días que tocaba jugar el videojuego fueron los días que yo tuve mayor asistencia porque ellos sabían que iban a ir a jugar, no querían faltar” (Docente de Historia, Colegio República de Estados Unidos).

5.3 Pensamiento Crítico

Como se expuso anteriormente, en el contexto de la presente investigación se define el pensamiento crítico como el desarrollo de las habilidades de análisis, comprensión y evaluación. Si bien, los efectos del videojuego en el pensamiento crítico fueron evaluados mediante la comparación de los resultados del pre y el post test de pensamiento crítico (Test de Cornell, Forma X), de manera complementaria en las entrevistas se indagó en la visión de los docentes respecto al impacto del videojuego en esta materia.

La mayoría de los docentes coinciden en que el desarrollo del pensamiento crítico es un proceso complejo y continuo, de modo que los alcances del videojuego se limitan a desarrollar una particular estrategia de enseñanza-aprendizaje: los mapas conceptuales:

"Sirve para ver la estrategia de enseñanza 'mapas conceptuales', sirve para eso, porque yo por ejemplo leí la introducción del video juego que era para desarrollar el pensamiento crítico y ahí yo discrepo. El pensamiento crítico yo creo que es un proceso sumamente largo, es un proceso que el recurso (videojuego) en sí no va a desarrollar en los estudiantes, porque es un proceso que parte desde el 'hola' que les digo en la mañana hasta el 'chao' cuando me voy de la sala, es un proceso mucho más acabado" (Docente de Cs. Naturales, Colegio Granja Sur).

Si bien la percepción de los profesores refiere a un limitado impacto del videojuego en el desarrollo del pensamiento crítico, los profesores señalan que es una herramienta que tiene un gran potencial para desarrollar habilidades presentes en el pensamiento crítico y sí reconocen que éste contribuye al desarrollo de algunas de las 3 habilidades contenidas en la definición conceptual de la investigación, así como al desarrollo de otras habilidades afines. En ello existe una cierta contradicción conceptual. En efecto, se plantea que el videojuego puede tener un impacto en el desarrollo del pensamiento lógico, en la capacidad analítica y en la capacidad de esquematizar y ordenar ideas. Por ello, es posible afirmar que los profesores tienen una concepción del pensamiento crítico diferente y más amplio que las definiciones conceptuales de la literatuta, adoptadas en la investigación.

La siguiente cita permite ilustrar la concepción de los docentes sobre el pensamiento crítico:

"No sé si puntualmente al pensamiento crítico, más que nada al pensamiento lógico, a esquematizar un poco tus ideas, desarrollar algunas habilidades y destrezas (…) yo creo que es un trabajo como más profundo, no solamente el videojuego (…) ellos ya venían con el conocimiento, entonces fue como el análisis lo que les sirvió, analizar y esquematizar" (Docente de Historia, Colegio Benjamín Subercaseaux).

Por otra parte, algunos profesores reconocer que el videojuego podría impactar en la habilidad de análisis:

"En lo analítico si porque tienen que leer el texto, tienen que leer, tienen que entender, se tienen que dar el tiempo de destacar qué es lo importante, que es lo que me va a llevar a hacer mi mapa conceptual" (Docente de Historia, Colegio República de Estados Unidos).

Otros profesores, si bien no conceptúan las habilidades de ordenamiento y esquematización como parte del pensamiento crítico, sí reconocen que éstas se desarrollan mediante la aplicación del videojuego:

"Yo pienso que aprendieron la parte de ordenar, de esquematizar" (Docente de Historia, Colegio República de Estados Unidos).

6 Conclusiones

A modo de síntesis, es posible afirmar que todos los docentes entrevistados tienen una valoración positiva de la incorporación de nuevas herramientas tecnológicas en la enseñanza, independientemente de su nivel de capacitación actual en las TICs. La mayor cercanía y familiaridad que ven entre los aprendices de las nuevas generaciones y la tecnología es una realidad que consideran debe ser atendida en función de mejorar el aprendizaje y la motivación:

"La tecnología aportaría en un mil por ciento para cambiar el paradigma tan conductista que hay sobre educación, que nos basemos en resolver problemas, en mirar desde otra perspectiva la educación, ya no tanto en que el niño mire la pizarra y copie, para mí eso ya es pasado. Para mí sería fundamental el hecho de que cada niño tuviera un aparatos tecnológicos dentro el aula" (Docente de Cs. Naturales, Liceo Granja Sur).

Sobre la práctica docente lectiva, se identificaron más aspectos positivos que negativos. Junto con los efectos actitudinales y conductuales ya descritos (motivación, sociabilidad, disciplina, concentración y asistencia), la mayoría de los docentes reconoce haber alcanzado los objetivos de aprendizaje y los resultados esperados en la clase:

"Yo quería ver si en realidad el video juego me ayudaba a ver resultados en el aprendizaje. El resultado fue sumamente positivo, los chiquillos eran muy buenos para armar mapas conceptuales. Y también lo vi en las pruebas" (Docente de Cs. Naturales, Colegio Granja Sur).

Por otra parte, existe una alta valoración del videojuego y la percepción generalizada de que con un mayor desarrollo de la herramienta es factible su incorporación en la planificación de sus respectivas asignaturas:

"Yo creo que tienen que ser etapas, que el juego vaya avanzando, que pasen de etapas y que la siguiente sea diferente, porque claro la primera vez les va a parecer entretenido pasarlo, la segunda también, pero ya la tercera…yo creo que tiene que ir agregándose dificultad. Yo creo que con etapas, porque ellos te comentan de otros juegos que tienen en los celulares 'profe voy ya en la etapa no sé cuánto'" (Docente de Historia, Colegio Benjamín Subercaseaux).

Con respecto a la motivación, destaca con un mayor incremento el rango de edad de 16 a 17 años y el curso de Séptimo año de Educación Básica, lo que puede encontrar su origen en que en estas edades existe una menor cantidad de recursos disponibles para aprender, lo que permiten que valoren más estas herramientas digitales. Dentro de los subsectores temáticos que incrementaron su motivación fueron física e historia, lo que encuentra su fundamento en el complemento practico que significó esta herramienta para estas áreas que siempre son trabajadas de manera tradicional.

Al realizar la comparación sobre la motivación por género, se obtuvo como resultado que el género femenino tuvo un aumento en la motivación a partir del uso del videojuego. Esto se puede explicar en base a que los hombres tienden a jugar más y valoran la gráfica con respecto a la temática del videojuego.

En cuanto al pensamiento crítico, los profesores señalan que es una herramienta que tiene un gran potencial para desarrollar habilidades presentes en el pensamiento crítico, sin embargo, es necesario que los estudiantes utilicen de forma periódica la aplicación. Estos resultados se vieron limitados debido a que por diversos acontecimientos a nivel de país y producto del paro (huelga) de profesores, los estudiantes solamente pudieron realizar 2 o 3 aplicaciones con el videojuego. Los profesores que enfrentaron dificultades de implementación (tales como fallas en la conectividad del colegio que afectaron la estabilidad de la plataforma y el paro de profesores) condicionan su evaluación del videojuego a la finalización del mismo:

"Si cumpliéramos todas las etapas yo creo que se lograría (fomentar habilidades de pensamiento crítico), pero como te digo el paro (sic, huelga prolongada) impidió que se lograran todas" (Docente de Matemática y Computación, Liceo Granja Sur).

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A ARTICULAÇÃO DE CONHECIMENTOS PEDAGÓGICOS PELO MAPA CONCEITUAL NA FORMAÇÃO DOCENTE EM ENFERMAGEM: UMA ABORDAGEM HISTÓRICO CULTURAL

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Resumo: a formação docente para formação de técnicos de enfermagem desenvolve-se em ações cotidianas, alicerçadas no diálogo entre os que ensinam e aprendem nas escolas profissionalizantes. Esta pesquisa objetivou analisar a articulação de conceitos da prática pedagógica na formação docente/enfermeiro, a partir de mapa conceitual analisado por abordagem histórico-cultural. Participaram 22 alunos dos 3º e 5º anos de um Curso de Bacharelado e Licenciatura em Enfermagem, nas disciplinas de Educação Profissional e de Estágio Curricular na Educação, que construíram os mapas conceituais tendo como palavras-chave "formação docente" e "prática pedagógica". Observou-se no Mapa Conceitual (MC) do 3º ano, uma pluralidade de palavras articuladas de forma incoerente, e que no MC do 5º ano, os alunos passaram a realizar associações e construir uma cadeia de eventos que embasam a formação docente. Considera-se que atividade refletiu e sintetizou as dimensões da prática docente, mediante exercício analítico cuidadoso dos alunos para interpretá-la criticamente no cotidiano.

1 Introdução

A formação docente para a educação profissional técnica de nível médio em enfermagem, responsável pela formação do técnico de enfermagem, desenvolve-se em ações cotidianas, alicerçadas na construção dialógica entre os que ensinam e aprendem nas escolas de ensino profissionalizante e nos diversos cenários de prática que a sustentam, como hospitais, unidades de atenção à saúde e laboratórios (Malheiros, 2013). Ações consubstanciadas, nos currículos e nos projetos pedagógicos dos cursos de bacharelado e licenciatura em Enfermagem, na articulação de atividades educativas desenvolvidas por acadêmicos deste curso de enfermagem, ao vivenciar as práticas pedagógicas. Deste modo, a articulação entre essas práticas implica em desafios na construção de tais habilidades pedagógicas e específicas no campo da enfermagem, necessárias às transformações e necessidades que ocorrem no mundo da Saúde e da Educação (Malheiros 2013; Cordeiro 2010). Nesta perspectiva, a licenciatura em Enfermagem se alinha às tendências pedagógicas contemporâneas na Educação que procuram superar o modelo tradicional em seu ensino, de base conteudista e reducionista, e avançar para aqueles que favorecem o pensamento crítico e reflexivo, a interdisciplinaridade, e a importância do contexto cultural. Com isso, a relevância deste estudo está ancorada na necessidade de compreender como o aluno de licenciatura constrói um conceito científico na área didático-pedagógica, numa proposta de educação crítica e reflexiva no processo formativo do futuro docente/enfermeiro, por meio do Mapa Conceitual(MC).

Os mapas conceituais são ferramentas gráficas que auxiliam na organização e representação do conhecimento, sendo amplamente utilizados na educação. Eles são construídos através de uma representação esquemática, nos quais são inseridos conceitos geralmente fechados em círculos ou caixas, que são interligados por uma linha de conexão. Nestas linhas é adicionada a especificação da relação entre os dois conceitos, destas caixas também podem surgir conexões com outras ideias, exemplos específicos de eventos ou objetos que ajudam a esclarecer o significado de um determinado conceito. Outra característica dos MC é que os conceitos são representados hierarquicamente, de forma que os conceitos principais são alocados na parte superior ou central do mapa, e a partir destes, os conceitos com importâncias menores são organizados hierarquicamente abaixo. Esta ferramenta fornece pontos de partida e permite que seu construtor vá além de refletir e organizar as ideias-chave e suas conexões, muitas vezes possibilita saltos criativos no processo de desenvolvimento das ideias, garantindo uma melhor qualidade e solução de problemas (Novak & Cañas 2008, Shelborne 2014). Diante do exposto, esta pesquisa objetivou analisar a articulação de conceitos da prática pedagógica na formação docente, por meio de mapa conceitual analisado a partir da abordagem histórico-cultural, na formação docente do enfermeiro.

2 Método

Pesquisa do tipo descritiva de natureza qualitativa, cujos dados foram analisados à luz da teoria histórico-cultural Vygotsky (2009, 2010), realizada no contexto de um curso de bacharelado e licenciatura em enfermagem de uma instituição pública de ensino superior do interior do Estado de São Paulo no Brasil. No referido curso de graduação, o estudante tem oportunidades de aprendizagem, na área da educação profissional a partir do terceiro ano, quando inicia o desenvolvimento de atributos (conhecimentos, habilidades e atitudes) para a docência no cenário da escola de educação profissional técnica nível médio em enfermagem, envolvendo dimensões políticas, gerenciais, pedagógicas e relacionais para compreensão e atuação neste contexto. No quinto e último ano, é esperado do aluno o aperfeiçoamento da competência para a docência na educação profissional, ao desenvolver a prática educativa no contexto das escolas profissionalizantes.

Foram incluídos neste estudo, 11 mapas conceituais construídos em duplas, estratégia de ensino que ocorreu no 1º semestre de 2015, com alunos do 3º e 5° ano do curso, em que participaram um total de 22 alunos. O tempo destinado para a atividade foi de 3 horas. Os MCs foram elaborados em cartolina e papel kraft, com pincéis próprios após as orientações iniciais do professor da disciplina. A questão norteadora foi: *Quais são os conhecimentos necessários na formação docente para EP em Enfermagem?* As palavras-chave foram Formação Docente; e Educação Profissional. Cada grupo apresentou o resultado de seu trabalho para os demais colegas e também explicaram o processo de construção dos MCs. Na sequência, os professores abriram discussões para estimular a reflexão e a crítica sobre o tema.

Para a análise dos dados, os MCs foram reproduzidos no *CmapTools Version 5.05.01 Lite* (Cañas et al., 2004), observando-se a formação dos conceitos à luz da teoria de Vygotsky (2009, 2010) que situa-se numa abordagem histórico-cultural. Segundo este autor (Vygotsky, 2010), criar métodos de ensino eficientes depende da compreensão de como ocorre a formação de conceitos científicos. Em seu estudo, indica que esta formação constitui-se de três estágios: no primeiro, há uma pluralidade não informada e não ordenada de objetos que apesar de discriminados são unificados sem fundamentação, sem semelhança ou relação entre as partes que o constituem; no segundo estágio, as generalizações são realizadas em atributos concretos, apresenta-se coerente, objetivo, em sua base há um vínculo factual entre elementos particulares que a compõem, chamado de complexo, nos quais os vínculos podem ser de cinco tipos: por associação, por coleções, por cadeia, por complexos ou pelo conceito potencial. Neste, a conexão de seus elementos é estabelecida mecanicamente; o aluno não possui a capacidade de avaliar a natureza das leis que unem o conjunto. Somente o conceito real ou verdadeiro contém ligações lógicas entre seus elementos que podem ser objeto de reflexão por parte do aluno, o que caracteriza o terceiro e último estágio da formação de conceitos científicos (Vygotsky 2009, 2010). Envolve a combinação e a generalização de determinados elementos concretos da experiência, sua discriminação, abstração e isolamento, e ainda, a habilidade de examiná-los e abstraí-los fora do vínculo concreto e fatual em que ocorreram. Assim, o objetivo da aprendizagem deve ser proporcionar a compreensão das leis que regem cada generalização, de forma que os conceitos sejam percebidos como sistemas, caracterizados por uma organização lógica e abstrata (Vygotsky 2009).

3 Resultados

Para apresentação dos resultados foram selecionados 2 MCs que representam a articulação dos conceitos expressos pelos alunos, sobre a formação docente para educação profissional técnica de nível médio em enfermagem. Na Figura 1, o MC construído pelos alunos do 3º, os conceitos foram hierarquizados e conectados conforme as sequências da experiência vivenciada na escola profissional. A partir do conceito de formação docente, este foi conectado aos conceitos da necessidade de apropriação da realidade, da observação da dinâmica escolar e de questionamentos que podem surgir, e que estão conectados em última instância com o "objetivo da aula". Também, conectaram as vivências ao conceito de aula expositiva, e esta aos conceitos de troca de experiências, dinâmica e planejamento, que está ligada à organização das atividades. Observou-se também que o conceito de dinâmica está conectado ao conceito de caso e de uma brincadeira (telefone sem fio).

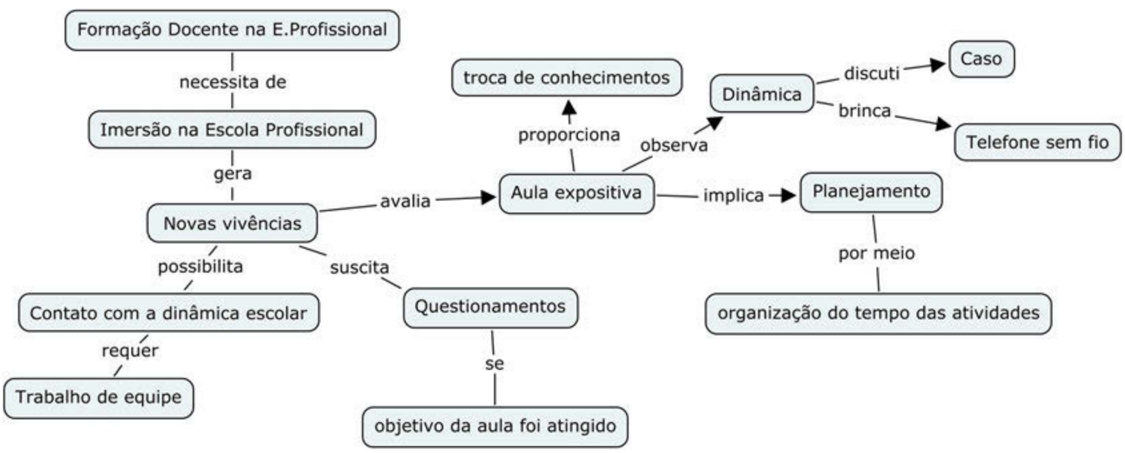

Figura 1. Mapa conceitual construído pelo 3º ano na disciplina de Educação Profissional

Na Figura 2, construída pelos alunos do 5º ano, observou-se que o MC também se apresentou hierarquizado, e contém 3 conceitos conectados diretamente à Formação Docente: conhecimentos específicos da enfermagem, da ética e da política educacional e didático-pedagógicos. A partir destes conceitos, os alunos colocam o verbo formar para o conceito de auxiliares e técnicos de enfermagem, e mais um verbo de ligação, atuar, ao conceito de Sistema de Saúde. Ao conceito de conhecimentos pedagógicos, estão conectados os conceitos de Projeto Político Pedagógico, Plano de Disciplina e Plano de Aula. Ao conceito de Plano de Aula estão conectados outros sete (7) conceitos: Dados de Identificação; Tema; Objetivos; Conteúdos; Método; Recursos Didáticos; Cronograma e Avaliação. Observou-se que ao conceito de Conteúdo, são explicitados vários sub-conceitos e a ligação com a ideia de Dúvidas e Aprendizado.

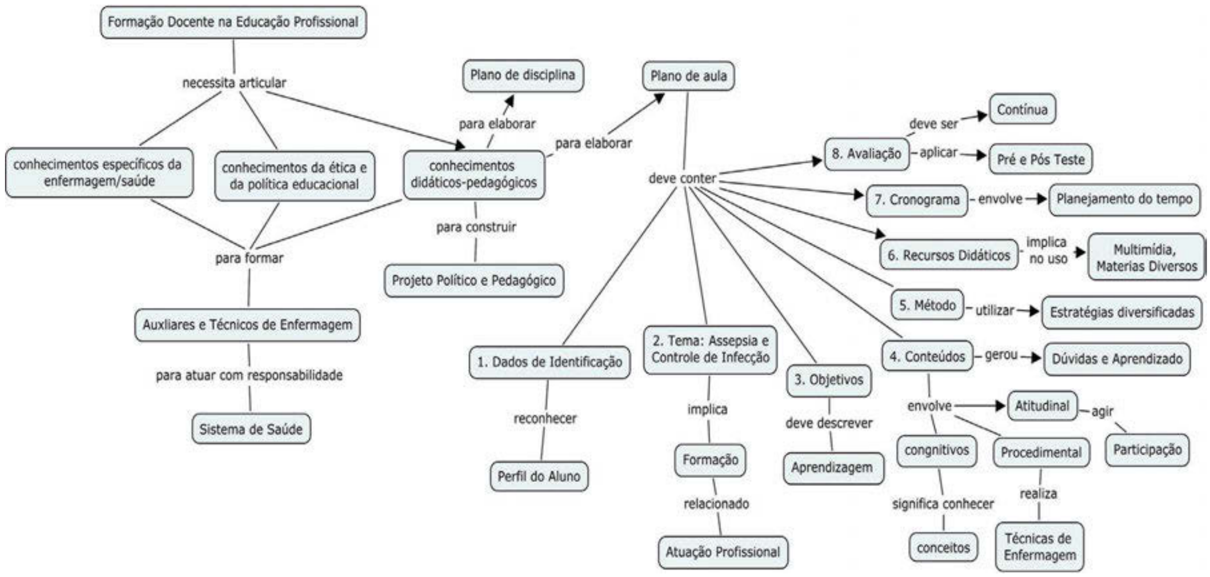

Figura 2. Mapa conceitual construído pelo 5º ano na disciplina de Estágio Curricular na Educação Profissional.

4 Discussão

A prática pedagógica na educação profissional de nível médio em enfermagem é um processo que envolve múltiplas dimensões: a formação do professor, o perfil do aluno, a metodologia de ensino, os objetivos e conteúdos de aprendizagem, as estratégias de ensino, a avaliação educacional e a relação entre professor e aluno (Malheiros, 2013). A utilização dos MCs como estratégia de ensino, nos permitiu a apropriação das objetivações de conceitos produzidas pela trajetória dos alunos na formação docente sobre estas dimensões em dois (2) momentos do curso. Vigotski interessou-se por suas transformações, ao caracterizar e até relativizar uma sucessão de etapas[5,6]. Ou seja, os conceitos expressos nos MCs representam um ato de generalização, entretanto, seu significado evolui[4]. As discussões a seguir fundamentam-se nas evidências dessa transformação, na perspectiva futura de realizar considerações sobre o processo de ensino e aprendizagem, que possibilita o ato de pensar de forma deliberada, sistematizada e intencional, na dinamicidade da formação docente. Dessa forma, articularam-se os estágios de formação de conceitos propostos por Vigotski, à construção dos MCs pelos estudantes de licenciatura em enfermagem.

No primeiro MC, encontra-se uma pluralidade de conceitos expressos, 1º estágio na formação dos conceitos segundo Vigotski (2010), nos quais identificamos uma carência de elementos para elucidar com clareza os fundamentos da formação docente. A aula expositiva encontra-se no centro do MC, o que demonstra a atenção e a relevância desta estratégia de ensino no cotidiano das escolas profissionais. E associou-se, num primeiro momento a prática pedagógica a um método tradicional de ensino, aquele em que os alunos permanecem passivos, esperam as informações, e acreditam que a aprendizagem se resume à repetição das mesmas (Malheiros 2013, Gubert 2011). Observa-se que os alunos tiveram algumas percepções e confundiram a relação entre os conceitos postos. Demonstrado pela conexão do conceito de dinâmica à aula expositiva. Por outro lado, indica que os alunos se envolveram numa formação problematizadora, valorizam os questionamentos e o reconhecimento da realidade.

Como demonstrou Vigotski, o significado das palavras são formações dinâmicas e dialéticas, que se modifica intrinsicamente, e deve ser compreendido como um processo contínuo de vaivém entre o pensamento e a palavra.

Cada pensamento tende a estabelecer relações entre as coisas e os fatos, assim amadurece e se desenvolve, desempenha uma função e soluciona um problema. Assim, o pensamento passa a existir por meio da palavra (Vygotsky 2009, 2010). Avanços na formação docente foram claramente identificados no MC do 5º ano, quando se observa os 2º e 3º estágios da formação de conceitos estudados por Vygotstky (2009, 2010), que pode ser reflexo do avanço na problematização acerca da questão posta, presente nos ciclos de aprendizagem, que possivelmente contribuem para o desenvolvimento das potencialidades do pensamento. Observou-se uma ampliação dos conceitos e sua articulação com a formação docente, assim como a presença das dimensões da prática pedagógica. Para Vigotski, o segundo estágio do processo de formação de conceitos científicos indica que o pensamento é coerente e objetivo e se dá por complexos (Vygotsky 2009, 2010). As diferenças entre o conceito científico verdadeiro, último estágio da sua formação, do complexo são as seguintes: se no complexo os objetos estão generalizados pelos fatos mais diversos, no conceito estão por um traço, que reflete um vínculo essencial e uniforme e uma relação entre os objetos; no complexo este vínculo é concreto, fatual e fortuito. No complexo, os objetos estão ligados por vínculos casuais diversos, frequentemente sem nada em comum entre si, enquanto o conceito se baseia em vínculos logicamente idênticos (Vygotsky 2009, 2010). Dessa forma, quando não devidamente problematizado, o desenvolvimento de um pensamento não atinge a sua verdadeira potencialidade, ou mesmo a atinge com certo atraso.

Além disso, identificaram-se no MC do 5º ano, vínculos associativos (Vygotstky 2010) entre os conhecimentos necessários para a formação docente sem, contudo especificá-los; os de coleções e por cadeia, quando conectaram o Projeto Político Pedagógico, Plana de Disciplina e Plano de Aula ao conhecimento didático-pedagógico que o professor deve desenvolver. Assim, embora o pensamento apresenta-se mais elaborado – isto é, mais associativo, complementar e integrado – destaca-se que ainda não se atingiu o pensar por conceito científico, último estágio de sua construção. Vemos também que, embora o pensamento esteja aparentemente mais organizado, não alcançou dimensões mais amplas sobre a formação docente em alguns aspectos[7,8]. Por fim, observou-se também a presença do conceito potencial, mais ainda por complexo, numa aproximação ao conceito verdadeiro. Quando os alunos tentam detalhar os componentes de um plano de aula, demonstram uma sistematização do pensamento, e uma articulação clara entre a teoria e a prática.

5 Conclusão

Conclui-se que a formação de conceitos construídos por alunos do Curso de Licenciatura em Enfermagem, em MCs sobre a prática docente, e analisada numa abordagem histórico-cultural, identificou seu 1º estágio no MC do 3º ano e o 2º e 3º estágios no MC do 5º ano. Considera-se que atividade por meio de MCs, refletiu e sintetizou as múltiplas dimensões da prática docente do aluno de licenciatura, mediante exercício analítico cuidadoso para interpretá-la criticamente no seu cotidiano.

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A CONTRIBUIÇÃO DO MAPA CONCEITUAL PARA O ENSINO DE CIÊNCIAS: GÊNESE, PRINCÍPIOS, CORRENTES E FINALIDADES

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Resumo: O artigo apresenta um estudo teórico descritivo sobre a contribuição do Mapa Conceitual para o Ensino de Ciências referindo, principalmente, a sua gênese, aos princípios que norteiam o trabalho educativo e investigativo, as diversas correntes de uso no Brasil e as possibilidades didáticas pedagógicas. Apresenta também algumas restrições e investigações com Mapa Conceitual na área do ensino-aprendizado em Ciências Naturais, atuando como recurso facilitador da aprendizagem significativa, em sala de aula no Ensino Fundamental. O estudo integra a tese de doutoramento sobre o tema, em que discutimos e investigamos a potencialidade do Mapa Conceitual em diferentes níveis de escolaridade. Na finalização do artigo, expomos Mapas Conceituais simplificados sobre os benefícios potenciais já identificados sobre o uso para o ensino e aprendizado, que tem sustentado investigações na área e tecemos algumas considerações a favor da incorporação do MC no codidiano da sala de aula.
Palavras-chave: Aprendizagem Significativa, Mapa Conceitual, Ensino de Ciências, Ensino Fundamental.

1 Introdução

O Mapa Conceitual (MC) têm sido alvo de diversos estudos em diferentes áreas do conhecimento, que atribuem a ele as mais variadas finalidades didáticas pedagógicas. Contudo, Moreira (2010) observa que o MC, ainda não incorporou, de fato, à rotina nas salas de aula. A observação, também foi evidenciada em investigações realizadas sobre o uso do MC no ensino fundamental, nos últimos 15 no Brasil. Este fato consolidou a necessidade de iniciar um movimento em prol do uso de MC, como recurso potencial de ensino no contexto da sala de aula e favorecer a adesão de professores. Nesta perspectiva, o estudo teórico descritivo, discute a contribuição do MC para o ensino e pesquisa no ensino de ciências e, apontam possibilidades, restrições, investigações, capazes de sustentar diferentes correntes, emergidas ao longo do processo de reconhecimento do MC como instrumento potencial de ensino e aprendizagem. Destacamos a importância de ampliar as investigações sobre a potencialidade do MC de modo a estimular os professores a fazer uso desse recurso de ensino no cotidiano da sala de aula e, a partir dele, obter dados provenientes de interpretações fundamentadas em diferentes possibilidades, ou seja, considerar as várias facetas que envolvem o processo de aprendizagem, emergidas do pensamento, sentimento e da ação, que de acordo com Novak (2000) povoam a natureza cognitiva do estudante na presença do MC.

2 Fundamentação Teorica

Para promover a aprendizagem significativa, Novak (1997; 2000); Novak e Gowin (1999), Moreira (2010) recomendam, ao educador, o uso de MCs como recurso didático, com a finalidade de identificar significados (subsunçores) pré-existentes na estrutura cognitiva do educando, que são necessários à aprendizagem. Ensinar utilizando MCs se torna importante para fazer pontes entre significados, assim como, estabelecer relações explícitas entre o novo conhecimento e aquele já existente, condição necessária para dar significado aos novos conteúdos de aprendizagem. Os MCs favorecem a compreensão da trajetória cognitiva percorrida pelo educando, quando o mesmo expõe os significados utilizando-se de uma linguagem clara, explícita e compartilhada, permitindo a externalização de sua atividade cognitiva. Portanto, são canais de manifestação da aprendizagem significativa como proposta por Ausubel (Ausubel, Novak & Hanessiam, 1980), e de acordo com Novak (1997, 2000), refletem também, maneira de pensar, sentir e agir. Logo, pode ser utilizado no ensino e na pesquisa sobre o ensino de ciências.

3 Metodologia

O método de investigação utilizado foi o estudo bibliográfico, que tem base em consulta ou pesquisa bibliográfica (Laville & Dionne, 1999). Por meio do estudo analisamos o que foi escrito, dito ou afirmado sobre o tema em referenciais teóricos publicados em livros, periódicos brasileiros e atas de eventos sobre ensino de ciências e MCs, buscando encontrar saberes e investigações pedagógicas relacionadas ao uso do MC no Ensino Fundamental, no Brasil, nos últimos 15 anos.

4 Resultados e Discussão

O estudo permitiu delinear a gênese do MC, capaz de oferecer um ponto de partida para a análise pedagógica do seu uso. De inicio, observamos que na tentativa de coletar dados junto aos estudantes, Novak e colaboradores utilizaram uma estratégia de ensino centrada na audição com estudantes de 6 e 7 anos. A estratégia foi trabalhada, também, com estudantes de 10 a 12 anos, permitindo novas análises. A aplicação desta estratégia de ensino nas salas de aula tornou-se bastante positiva. Depois de permanecer dois anos em estudo, os mesmos estudantes, passaram por entrevistas periódicas. No entanto, com as entrevistas, vários problemas foram gerados, por exemplo, a dificuldade em estabelecer padrões em mudanças na compreensão conceitual por meio das transcrições elaboradas a partir de gravações. Surgiu, então, a necessidade de buscar um método que viesse dar conta de representar a estrutura cognitiva dos estudantes e evidenciar a ocorrência de avanços na aprendizagem. Isso implicou em buscar os princípios teóricos de Ausubel, capazes de sustentar formas de representar as ideias dos estudantes, como uma estrutura organizada hierarquicamente de conceitos e proposições. Estas representações originaram em um novo mecanismo de estrutura do conhecimento que foi denominado de mapas de conceitos, construídos por meio das transcrições das entrevistas clínicas, realizadas para representar o conhecimento dos estudantes (Novak, 1997, 2000). O novo mecanismo de registro evidenciou que o estudante estava aprendendo, de forma significativa ciências, quando elaborava as suas estruturas conceituais, embora manifestasse também concepções errôneas, falta de conceitos e outras ideias mais. A partir do momento em que as entrevistas passaram a ser analisadas por meio de MCs, ofereceram um importante material de investigação. Os dados, conforme os autores, são coerentes com o fundamento teórico utilizado. Isso revela que o mapa de conceitos permitiu observar mudanças específicas na estrutura cognitiva dos estudantes investigados mais facilmente e de forma mais precisa, assim como, demostrou eficiente para desvendar concepções alternativas. Os MCs se constituíram, na sua origem, como uma ferramenta de representação do conhecimento, baseado na ideia "que todo o conhecimento é construído pelos seres humanos e consiste em conceitos e proposições" (Novak, 1997, p.68).

Desde então, estudos têm demonstrado possibilidades e restrições de uso do MC, por exemplo, no aspecto didático pedagógico o MC é considerado atividade instigante e provocadora, que motiva e valoriza a contribuição do estudante, permite dirigir a atenção com relação ao conjunto de idéias, consideradas importantes, nas que se pretende concentrar uma tarefa específica de aprendizagem. A elaboração de um MC é considerada uma atividade criativa, na medida em que atua como mecanismo heurístico, permitindo ao estudante construir novas relações e, por conseguinte novos significados (Novak, 1997). Gowin e Alvarez (2005) ressaltam que o MC permite externalizar pensamentos do estudante. Isso facilita alcançar os objetivos de aprendizagem e explicar como ele está sendo alcançado. Por se apresentar como uma técnica muito flexível pode ser usada em diversas situações e com diferentes finalidades. Ao gerenciar o pensamento é capaz de promover reflexões, atuando como um instrumento metacognitivo, favorecendo o aprender a aprender. Quando elaborado pelo estudante tem significado pessoal, e os diferentes significados poderão evidenciar o bom entendimento da matéria ensinada, não havendo necessidade de dizer que um é melhor do que outro e muito menos que um é certo e outro errado (Moreira, 2010). Por outro lado, deve-se estar atento quanto às relações conceituais elaboradas. Estar atento não significa dizer que MC elaborado é inadequado, por ser dinâmico adquiri diferentes configurações durante o processo de aprendizagem (Moreira, 2010). Apesar de ser um instrumento didático diferente dos outros, o MC deve ser avaliado qualitativamente a fim de obter evidências de aprendizagem significativa, pois não faz sentido avalia-lo, apenas de forma quantitativa. A recomendação é solicitar a explicação oral ou escrita em relação ao MC elaborado, permitindo a externalização de seus significados, tanto os conotativos como os denotativos (Novak, 1997, Moreira, 2010, Silveira, 2014).

Apesar da potencialidade significativa do MC, estudada e divulgada pelos seus defensores, para o ensino e investigação no ensino de Ciências, observamos que as investigações sobre o MC, no ensino fundamental no Brasil, não são assim tão animadores. Os relatos de experiências e as publicações de investigações são escassos e quando aparecem, na maioria das vezes, não são subtraídas do cotidiano da sala de aula ou reveladas pelo proprio professor. Este fato foi comprovado por análise de documentos (artigos) provenientes de diversos eventos de ensino das Ciências e investigações em ensino, publicados em periódicos nacionais e eventos realizados nos ultimos 15 anos, dos quais citamos alguns exemplos. Loureiro, et al (2010) utilizou MC na aprendizagem dos conceitos. Ferracin, Cervigne e Klein (2005) procurou identificar os conhecimentos e atitudes. Infante-Malaquias, Correia e Silva (2006) investigaram o potencial do MC na avaliação da aprendizagem de conceitos científicos. Mendonça e Silveira (2012) dedicaram à análise progressiva dos MCs. Nas Conferências Internacionais de MCs foram apresentados por pesquisadores brasileiros 125 artigos, destes, apenas 10 se referiam a investigações no Ensino Fundamental. Contudo, a maioria das investigações é realizada de forma pontual, por pesquisadores externos a escola, que planejam um momento diferenciado das aulas do dia para a coleta de dados junto aos estudantes. Assim, a análise dos resultados ocorre somente a partir do produto final, ausente do movimento pedagógico que deu identidade a aquela produção, acarretando em utilização ingênua dos MCs produzidos pelos estudantes. Segundo Correia, Silva e Romano Junior (2010) a utilização ingênua dos MCs pode produzir poucos (ou nenhum) dos benefícios até agora apontados. É necessário comprender que a potencialidade didática do MC, apenas será construída pelo estudante ao compartilhar a sua elaboração com os seus pares em uma relação dialógica entre ele e seu MC (Silveira, 2014).

Atualmente, quanto à abordagem educativa e investigativa do MC, temos em conta que a maioria de seus usuários, adota diversos discursos e propõe diferentes maneiras de conceber e praticar uma ação didática ou pesquisa educativa adotando essa abordagem. A partir dessa questão, identificamos *correntes* de uso do MC, que em alguns pontos compartilham de características comuns. Consideramos três correntes vigentes no Brasil: a *Tecnológica Empresarial* centra-se na educação informal, reúne aqueles que veem no uso do MC uma ferramenta para aperfeiçoar habilidades e competências na empresa, tanto na gestão de pessoas, como dos negócios e conhecimentos, visa aumentar à eficiência e eficácia das organizações empresariais em tudo aquilo que lhes competem. No Brasil, foi identificada em estudos de Oliveira (2006), Bizarro (2014), entre outros. A corrente *Tecnológica Educacional* centra-se na educação formal e informal, agrega aqueles que apostam na informática como uma ferramenta inovadora do ensino, criando softwares para elaboração de MCs. São criadas comunidades de interação para a divulgação de seus estudos e pesquisas na web, estendendo as suas produções a educação informal. É identificada em estudos de Nunes, (2010), Cury, Perin e Santos Jr. (2014) e outros. A corrente *Didática Pedagógica* está centrada na educação formal e agrega aqueles que apostam no uso do MC na sala de aula ou em investigações sobre seu uso no processo de ensino e aprendizagem, na gestão escolar, currículos e na avaliação. Pode ser reconhecida em estudos de Mendonça, Lemos e Moreira (2010), Cavalheiro, Wanmacher e Del Pino (2013), entre outros. Para aqueles que se inserem na corrente Didática Pedagógica, a dimensão escolar é ampla, envolve desde as políticas educacionais e a organização do ensino. Consideram que conhecer a dimensão no qual a escola está inserida, demanda compreender a problemática do processo de ensino-aprendizagem e intervir a favor dele. Isso implica em aproveitar essa compreensão para a busca de soluções plausíveis de intervenção.

5 Considerações

Desde a sua origem, o MC tem servido a pesquisa e ao ensino de Ciências (figura1 e 2). A diversidade de utilização revela a sua potencialidade como uma ferramenta educativa, alvo de vários estudos no Brasil. Contudo, os seus adeptos adotam diferentes discursos e impõem diversas maneiras de conceber, investigar e praticar uma ação educativa usando o MC, situando-os em diversas correntes quanto a sua aplicação, finalidades e enfoques que, em alguns casos, acabam por desviar da finalidade do MC proposta por Novak em sua criação. O estudo revelou que o MC deve ser defendido como um recurso didático potencial para o ensino de ciências. Reiteramos o nosso anseio em incorporar o MC como recurso didático a rotina das salas de aulas, disseminar as estratégias de intervenção e os resultados obtidos no sentido de manter um movimento de discussão e colaboração com os demais pesquisadores e educadores em ciências interessados no tema, com isso, ampliar a Corrente Didática Pedagógica**,** com ênfase na aplicabilidade do MC na sala de aula do Ensino Fundamental.

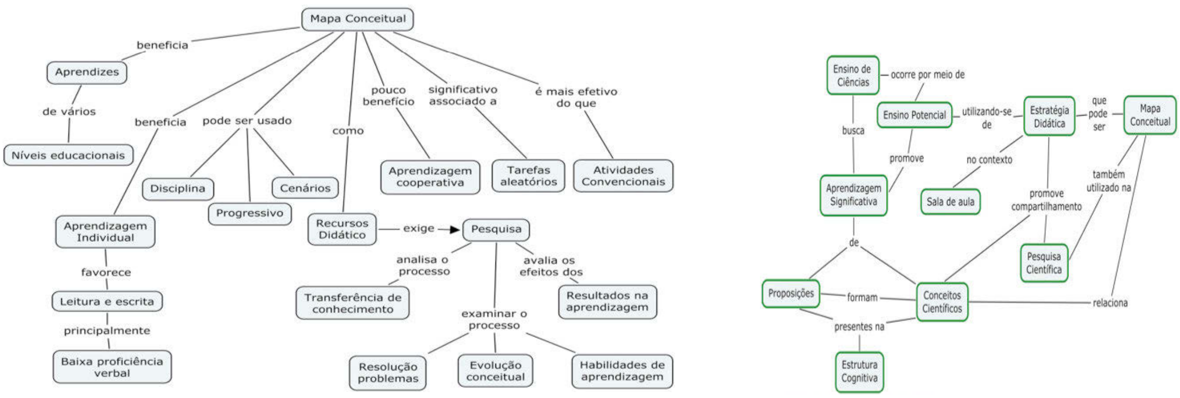

Figure 1 e 2 - Demonstrativo da potencialidade do MC para o ensino e pesquisa no ensino.

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APRENDIENDO CIENCIAS NATURALES HACIENDO MAPAS CONCEPTUALES

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Resumen: Se presenta una experiencia de trabajo con mapas conceptuales en el aula de 4º de Educación Primaria del CEIP Puig de Sa Morisca, Mallorca. El objetivo de la experiencia fue desarrollar, implementar y evaluar una estrategia para favorecer la inclusión de los mapas conceptuales en la Educación Primaria. La estrategia incluyó una secuencia de tres actividades de desarrollo de mapas conceptuales. Para la evaluación de la implementación de la estrategia se recogió información sobre los resultados de aprendizaje, el procedimiento, el tiempo invertido, la actitud de los alumnos, así como del manejo de la herramienta CmapTools. Los resultados obtenidos fueron muy satisfactorios.

1 Introducción

Los mapas conceptuales son una herramienta potente para organizar, representar y almacenar el conocimiento, constituyendo una de las principales aplicaciones prácticas de la teoría de Novak (1998) sobre el aprendizaje significativo frente al aprendizaje memorístico (Salinas, de Benito y Darder, 2011).

Existen distintas experiencias que nos muestran el trabajo con mapas conceptuales en aulas de Educación Primaria. Mendoça y Silveira (2012) han trabajado las Ciencias Naturales utilizando mapas conceptuales en tres momentos diferentes, antes, durante y después del desarrollo de los temas del currículo; Martínez et al. (2014) diseñan y proponen módulos instruccionales a partir de mapas conceptuales elaborados con la herramienta CmapTools (Cañas et al., 2004) y Rodríguez (2006) propone un taller que tiene, entre otras finalidades, la de comprender la importancia de la construcción de mapas conceptuales y saber identificar aspectos relevantes para la construcción de mapas conceptuales. Todas estas son experiencias relevantes que están centradas en las teorías de Novak y Ausubel sobre el aprendizaje significativo.

La experiencia que se presenta busca probar una estrategia pautada y secuenciada para introducir a los alumnos de Educación Primaria en el aprendizaje con mapas conceptuales.

2 Metodología

Se ha seguido una metodología basada en la investigación y desarrollo de acuerdo al modelo instruccional iterativo ADDIE siguiendo las fases descritas por McKenney y Reeves, 2012. Dicho modelo establece un proceso de diseño interactivo de soluciones educativas en cuatro fases: Análisis del problema, Diseño, desarrollo e implementación de soluciones; Ciclos iterativos de evaluación; Reflexión y creación de principios de diseño. La recogida de información durante la implementación se ha realizado mediante rúbrica y observación participante. La rúbrica se ha utilizado para evaluar los aprendizajes y los mapas desarrollados por los alumnos y la observación participante sobre ambiente de clase y desarrollo de la estrategia.

La experiencia se desarrolla con un grupo de 25 alumnos de 4º curso de Educación Primaria del CEIP Puig de Sa Morisa (Calviá, Mallorca, Islas Baleares, España) y su maestra. El criterio de selección del grupo responde al criterio de conveniencia, y la relación entre la investigadora, la maestra y el grupo.

3 Diseño de la estrategia e implementación de la estrategia

La estrategia pretende introducir el trabajo con mapas conceptuales de forma escalonada de acuerdo al grado de complexidad, ofreciendo a los alumnos una herramienta con la que poder estructurar su conocimiento y aprender significativamente desde actividades reales y cercanas al alumno. Se diseña una secuencia de 3 actividades para trabajar contenidos de ciencias naturales, de 4ª curso de educación primaria, con mapas parcialmente estructurados para favorecer que el alumno desarrolla las competencias necesarias para trabajar con mapas (organizar conceptos, relacionar con conectores adecuados). Las tres estructuras o plantillas de mapa conceptual, diseñadas de acuerdo a estrategia fueron:

- Organizar conceptos. Se ofrece la estructura de un mapa con los conectores y el alumno debe trasladar los conceptos dados por la investigadora al espacio correcto.

- Organizar conectores. Se ofrece la estructura de un mapa con los conceptos y se pide al alumno que escriba conectores adecuados.
- Generar un mapa conceptual a partir de conceptos y palabras enlace dados.

El procedimiento de desarrollo de las actividades se realizó en tres sesiones de 55 minutos cada una. Cada una de estas sesiones incluye una serie de rutinas. Para realizar cada una de las actividades los alumnos debieron estudiar previamente el tema indicado en cada una de las actividades. Una vez en clase, cada alumno con el ordenador portátil accedió a la herramienta CmapTools guiados por el profesor/a hasta el lugar exacto donde pudieron encontrar la estructura del mapa conceptual a completar. Cada alumno abrió el mapa y lo guardó en el mismo programa CmapTools con su nombre y luego, la maestra hizo una explicación y demostración de cómo se hacía la actividad mediante la pizarra digital del aula. Una vez concluida la explicación los alumnos y alumnas comenzaron a realizar la actividad planificada. Una vez finalizada, cada alumno guardó su mapa conceptual y así, la investigadora puedo ver todos los mapas conceptuales realizados desde su ordenador para evaluarlos.

Actividad 1. Organizar conceptos

Los alumnos empezaron a familiarizarse con los mapas conceptuales y con la herramienta 2.0 CmapTools a partir de esta primera actividad, trabajando el Tema 5, La materia y los materiales. La imagen 2 presenta el mapa conceptual utilizado en esta actividad, en la cual se puede apreciar el título, las palabras enlace y algunos de los conceptos y en la parte inferior, en color amarillo, se muestran otros conceptos que los alumnos tenían que organizar arrastrando o escribiéndolos en el lugar adecuado.

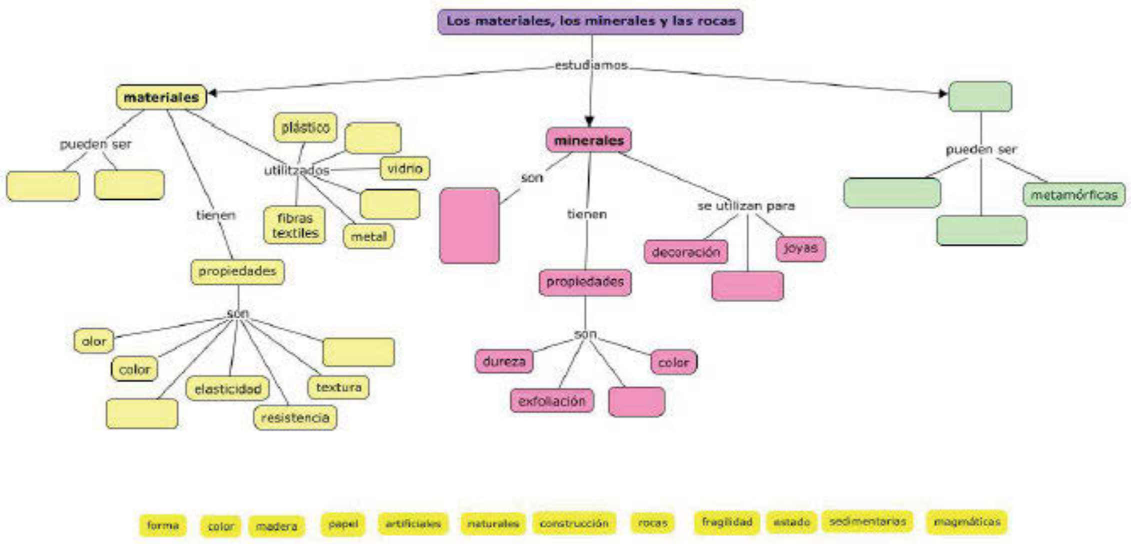

Imagen 1. Actividad basada en organizar los conceptos.

Actividad 2. Trabajar con conectores

Para realizar esta segunda actividad los alumnos estudiaron el tema 6, La energía. En este caso el alumno debe identificar y escribir las palabras enlace que relacionaran bien los conceptos que aparecían en el mapa. La imagen 3 muestra el mapa conceptual utilizado. Este mapa presenta el título, los conceptos y, en blanco, el espacio para anotar las palabras enlace. Esta vez no se les dieron palabras enlace para colocarlas si no que las pensaron y las escribieron ellos mismos. La maestra, previamente, tuvo que explicar el significado de palabras enlace poniendo ejemplos que facilitaran al alumnado la elaboración de esta actividad.

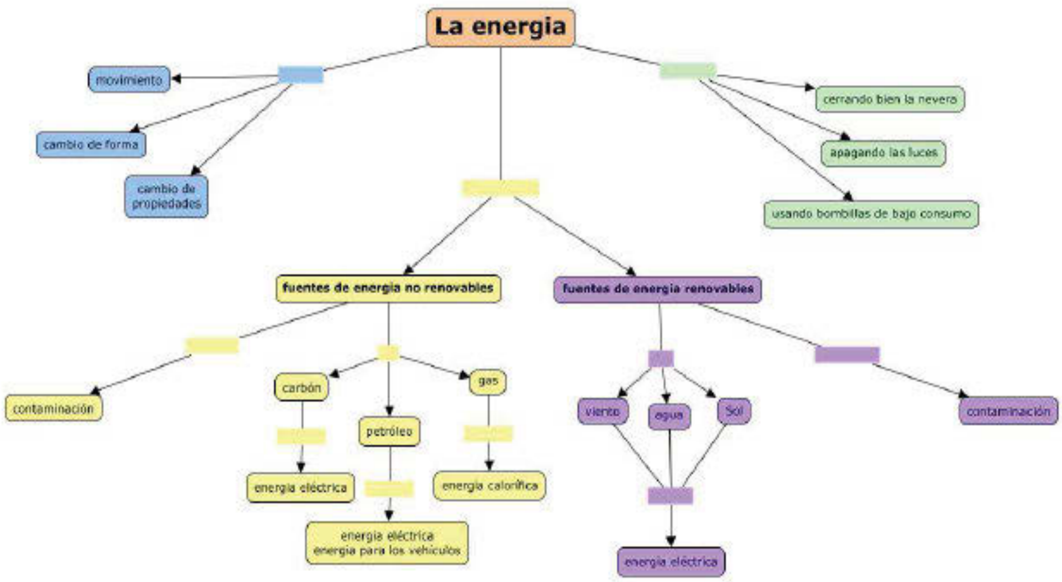

Imagen 2. Trabajar con conectores.

Actividad 3. Creación del mapa conceptual

La actividad trabaja sobre el tema 7, Las máquinas. Esta actividad consistió en generar un mapa conceptual con CmapTools a partir de las palabras enlace y los conceptos proporcionados por la maestra. La imagen 4 muestra el mapa presentado al alumno.

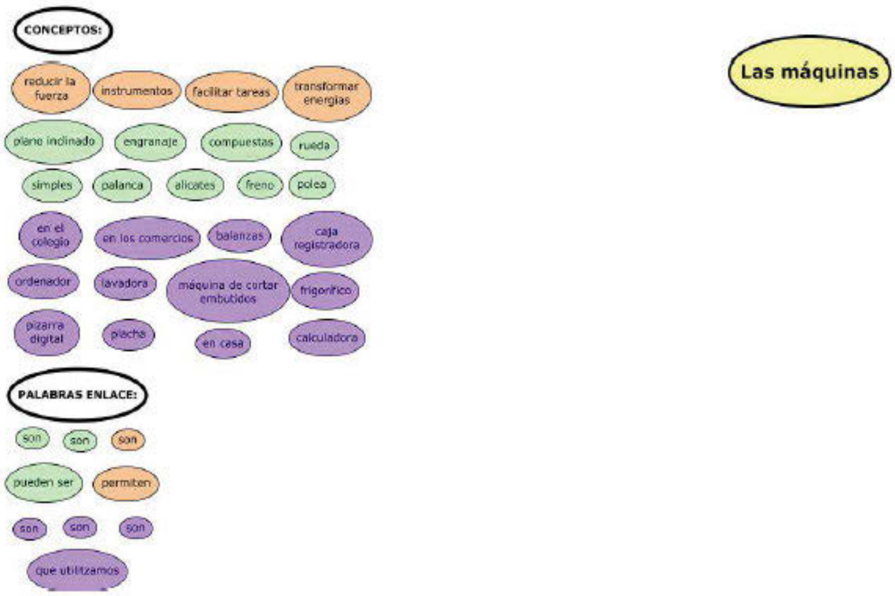

Imagen 3. Creación del mapa conceptual partiendo de conectores y conceptos dados.

4 Resultados

La evaluación de la estrategia se realiza a partir de los resultados de aprendizaje y la observación participante en el desarrollo de las sesiones.

Todos los alumnos y alumnas participaron activamente en las tres actividades. Se evaluaron las actividades de acuerdo a la adecuada colocación de conceptos, palabras enlace, jerarquía, proposiciones y diseño visual. Los resultados globales de cada actividad se muestran en el Gráfico 1. La gran mayoría realizó la primera actividad correctamente, sólo un pequeño porcentaje la hizo bien y ningún alumno/a lo hizo ni regular ni mal. En cambio, en la segunda actividad, se puede ver que aunque más de la mitad de la clase la hizo muy bien, algunos alumnos/as la hicieron bien, regular o mal así como la tercera actividad, con un porcentaje parecido aunque un poco menor de alumnos que la hicieron muy bien, bien, regular o mal.

	Muy bien	Bien	Regular	Mal
Actividad 1	92%	8%	0%	0%
Actividad 2	64%	28%	4%	4%
Actividad 3	60%	16%	12%	12%

Gráfico 1. Resultados de las actividades.

Una manera de mejorar los resultados de la segunda y tercera actividad sería repitiendo la segunda actividad una o dos veces más ya que, se aprecia que no la han sabido hacer tan bien como la primera, de esta manera mejorarían el trabajo con las palabras enlace objetivo de la segunda actividad y a su vez realizarían mejor la tercera actividad.

El clima de clase fue excelente, los alumnos y alumnas fueron muy receptivos, estuvieron muy implicados en las actividades des del primer momento mostrándose interesados, atentos y preguntando aquello que no entendían. Las sesiones se desarrollaron en el tiempo previsto. La herramienta CmapTools ha permitido el desarrollo de las actividades y los alumnos la han sabido manejar correctamente.

5 Conclusiones

La experiencia fue positiva para los alumnos y alumnas, para la maestra y para la investigadora. Se cumplieron las expectativas, los alumnos se introdujo a los alumnos al aprendizaje con mapas conceptuales, entendieron qué son, para qué se utilizan y cómo se hacen, y además, aprendieron a manejar la herramienta CmapTools

Las tres actividades son un ejemplo de inclusión de los mapas conceptuales utilizando el contenido curricular del curso y aprender a aprender con mapas conceptuales. La utilización de mapas semiestructurados así como la secuencia se considera adecuada y una buena estrategia para aplicar en clase y se considera interesante replicar la experiencia con otros grupos de Educación Primaria o Secundaria y con otros materiales.

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APUNTES METODOLÓGICOS PARA LA CONSTRUCCIÓN DE MODELOS DE CONOCIMIENTO

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Resumen. Los modelos de conocimiento basados en mapas conceptuales representan una oportunidad para la preservación y la difusión del conocimiento, sin embargo, su elaboración requiere de más elementos que el dominio de la técnica del mapa conceptual y del dominio del área de conocimiento. Con base la recuperación reflexiva de la experiencia de diseño y construcción, se plantea un proceso de 7 pasos para el diseño y desarrollo de modelos de conocimiento basados en mapas conceptuales.

1 Introducción

La evolución de las formas de construir, compartir y utilizar los mapas conceptuales ha dado origen a diferentes formas de comprender las funciones formativas del mapa conceptual y han hecho evolucionar la estructura del mapa mismo. La inclusión de las herramientas tecnológicas como CmapTools (Cañas et al. 2004) ha permitido diversificar los usos del mapa conceptual (Aguilar Tamayo, 2006, P. 3; Cañas *et al*, 2000 pp. 150-153). Entre esos se encuentra la construcción de *Modelos de conocimiento basados en mapas conceptuales* (Cañas *et al*, 2000, p. 150)

Existen trabajos que describen las experiencias de elaboración de modelos de conocimiento para mostrar los resultados de la interacción de diferentes usuarios con ellos, o como metodología de aproximación a sus objetos de estudio (conceptos, sucesos, eventos o teorías), ejemplos de este tipo de trabajos son: García, 2011; Flores, 2104, Suero, 2014; Díaz, Flores, García & Ibarra, 2010; García, Noyola, Aguilar, 2012; Heano & Rodríguez, 2012 que presentan una perspectiva de aplicación, aunque son pocos los párrafos que dedican a describir la metodología que siguieron para la construcción del modelo de conocimiento.

Sí nos acotamos a las definiciones más comunes del "modelo de conocimiento basado en mapas conceptuales" (Cañas *et al*, 2000, p. 146; Cañas *et al*, 2003; García, 2011, p. 21; Gonzáles *et al*, 2013, p.115), podemos creer que los modelos de conocimiento se reducen a la interacción mecánica de recursos en un soporte tecnológico, sin considerar la intencionalidad comunicativa y educativa que se tiene al generar el objeto y que repercuten de manera importante en la forma en que se elabora un modelo de conocimiento.

El presente trabajo tiene como propósito documentar una metodología para el desarrollo de un modelo de conocimiento basado en mapas conceptuales, partiendo desde una perspectiva comunicativa y educativa sumada a la naturaleza de preservación del conocimiento que se le ha otorgado a este tipo de modelos.

2 Documentación del Proceso de Elaboración de un Modelo de Conocimiento

Para realizar el proceso de documentación elaboró un modelo sobre el concepto "construcción de conocimiento" presente en la obra de Novak a partir de la revisión de los textos Conocimiento y aprendizaje (Novak, 1998) y Aprendiendo a aprender (Novak & Gowin, 1988)

Al ser una *representación externa* (Martí, 2003), que será consultada por otros y no sólo por su autor, se presentan varios retos para la elaboración del modelo de conocimiento:

1. Verificar que los mapas que lo conformarán, han sido elaborados con la intención de ser interpretados por terceros y no sólo por su autor. Este paso es necesario ya que en primer momento los mapas conceptuales sirvieron como herramienta de estudio del concepto "Construcción de conocimiento" para quien los elabora, por lo cual podríamos tener mapas que cumplen función de autoestudio pero no de comunicación a un tercero.
2. Garantizar que las interconexiones permitirán una navegación clara y que en todo momento existirá la forma de regresar al principio del modelo para orientarnos en su navegación. Esta característica es importante dado que si bien, los mapas pueden ser elaborados con la intención de que otro los comprenda, será necesario que la navegación entre mapas y recursos sea fácil.

Para trabajar el modelo de conocimiento se partió de un proceso de revisión de los mapas que conformarían el modelo, para ello la revisión documental permitió determinar los conceptos relacionados con el concepto principal (construcción de conocimiento) y en segunda instancia determinar las preguntas de enfoque que serían respondidas por los mapas.

Se determinó iniciar con diez preguntas que surgieron al momento de hacer la revisión de literatura acerca del concepto construcción de conocimiento. Las preguntas son las siguientes:

1. ¿Cuál es la propuesta teórica de Joseph Novak con respecto al proceso de construcción de conocimiento?
2. ¿Qué es el aprendizaje?
3. ¿Qué es el aprendizaje significativo?
4. ¿Qué es el conocimiento?
5. ¿Cuál es la naturaleza del conocimiento?
6. ¿Qué es la construcción del conocimiento?
7. ¿Cuál es el ciclo de construcción del conocimiento?
8. ¿Qué es un concepto?
9. ¿Para qué sirven los conceptos?
10. ¿Qué es un mapa conceptual?

2.1 La Elaboración de Mapas Conceptuales

Novak (1988) menciona que "La elaboración de mapas conceptuales es una técnica destinada a poner de manifiesto conceptos y proposiciones" (p. 35). Generar proposiciones implica procesos de análisis, reflexión y comprensión, por lo que la elaboración de mapas puede ser considerada como una forma de generar experticia en un área de conocimiento y por ende la posibilidad de elaborar un modelo de conocimiento basado en revisión documental.

Para elaborar los mapas conceptuales que conformarían el modelo de conocimiento se partió de elegir un tema de la teoría a estudiar y se realizaron varias lecturas que permitieron identificar la presencia de dichos temas en secciones y capítulos específicos de la obra. Se elaboró un listados de conceptos que ayudarían a responder las preguntas de enfoque, posteriormente se elaboraron los mapas conceptuales. Sin embargo, estos primeros mapas no representaban todas las relaciones, ni contenían todos los conceptos necesarios para responder las preguntas de enfoque, por lo que la revisión detallada de los textos, así como la reelaboración y modificación argumentada fueron elementos fundamentales para obtener los mapas finales.

La búsqueda de recursos adicionales realizada a la par de la construcción de mapas llevo al punto en el que las preguntas planteadas inicialmente eran insuficientes para lograr describir el concepto "Construcción de conocimiento" de Joseph Novak, por lo que a las diez preguntas iniciales se le agregaron cinco más, convirtiéndose en 15. Las cinco preguntas que se agregaron durante el proceso fueron las siguientes:

1. ¿Qué son los constructos?
2. ¿Para qué sirven los mapas conceptuales?
3. ¿Cuáles son los elementos que conforman al mapa conceptual?
4. ¿Qué es una proposición?
5. ¿Qué es el significado?

El modelo completo no se presentará en este documento dado que la intención no es presentar a detalle el modelo de conocimiento elaborado como una experiencia, sino documentar el proceso de construcción de manera detallada para su posterior replicación. El modelo puede ser consultado en: https://goo.gl/oC0179

3 La Propuesta Metodológica para Elaboración de Modelos de Conocimiento basados en Mapas Conceptuales

Derivado de los procesos de los procesos de revisión de literatura, construcción de modelo de conocimiento y recuperación reflexiva de esta experiencia, la propuesta etapas para la elaboración de un modelo de conocimiento es la siguiente:

1. Elección del objeto a modelar: La definición del tipo de objeto a modelar determinará la forma en que se aproxima al proceso de mapeo mediante las etapas "2A" que es el registro y estructuración del conocimiento experto o "2B" que es una revisión documental, se puede modelar una teoría, un principio, un concepto, un proceso o el conocimiento experto sobre un tema

2 A. Registro y estructuración del conocimiento experto: La estructuración puede ser realizada mediante el establecimiento de varias preguntas de enfoque. Sobre el modelaje del conocimiento experto visualizamos dos posibilidades: A) que el propio experto haga el mapeo de su conocimiento, lo cual requiere que el experto domine la técnica del mapa conceptual; es importante indicar que en este escenario el paso 5 se realiza al mismo tiempo que se realiza la construcción de los mapas. B) Que se otra persona la que realice el mapeo de su conocimiento, en caso de que el experto no domine la técnica del mapa conceptual. En este caso se requeriría del paso 5, en el que el experto validará los mapas elaborados por alguien más sobre su conocimiento.

2 B. Revisión documental: En el caso que se elija una teoría, principio, concepto o proceso, será necesaria la revisión documental, primero para el proceso de comprensión general para plantear las preguntas de enfoque iniciales, pero posteriormente a profundidad y a detalle para realizar el mapeo correspondiente. Este tipo de modelaje puede resultar útil para procesos formativos de estudiantes, profesores o profesionales para quienes el proceso de construcción de un modelo de conocimiento ayudaría en el desarrollo de la experticia en el tema.

3. Elaboración de mapas conceptuales: La elaboración de mapas conceptuales requerirá un proceso de análisis profundo de la información y del conocimiento poseído. Este proceso implica el dominio de la técnica y la interpretación de las fuentes de información o del propio conocimiento en el caso que se parta de etapa 2. Aunque se plantea como etapa 3, esta etapa puede ser revisitada a lo largo de las etapas 4 y 5, dado que la naturaleza de estas revisiones llevará en la mayoría de los casos a la re-elaboración o modificación de los mapas.

4. Elección de la forma de navegación: Si bien es cierto que los conceptos permiten llevar al reto de mapas relacionados con ellos, es importante vigilar que en todo momento sea posible regresar al mapa de navegación, así como permitir que en el mapa inicial o de navegación estén enlazados los conceptos más importantes. Este principio implica establecer una estructura jerárquica de los mapas conceptuales que conforman el modelo de conocimiento.

5. Pilotaje: Una vez realizada la vinculación de mapas y recursos, cuidando la navegabilidad de MCBMC, es recomendable realizar un proceso de pilotaje para verificar que los mapas sean claros y que las conexiones permitan realmente navegar de las formas que se han establecido.

6. Validación de experto: Cuando es el experto quien se encuentra mapeando su propio conocimiento la validación se encuentra implícita en el paso 3. En el caso de los modelos que se desarrollan por medio de la revisión documental, el proceso de validación es importante para verificar que la interpretación sea lo más apegada posible a la teoría. Esta segunda opción puede utilizarse como evaluación en procesos formativos de grado o posgrado y se propone que la validación sea realizada por el director de tesis y los sinodales.

7. Publicación: La publicación del modelo de conocimiento implica poner a disposición de quien requiera dicho modelo. Este proceso puede implicar en su concepción más amplia la puesta en línea por medio de algún sitio web, blog o registro en repositorios en línea sin embargo también puede optarse por opciones más controladas como aulas virtuales con acceso restringido o el simple hecho de presentación en clase.

La propuesta de *metodología de construcción de un modelo de conocimiento* representado en un Mapa conceptual podría quedar expresado de la siguiente manera:

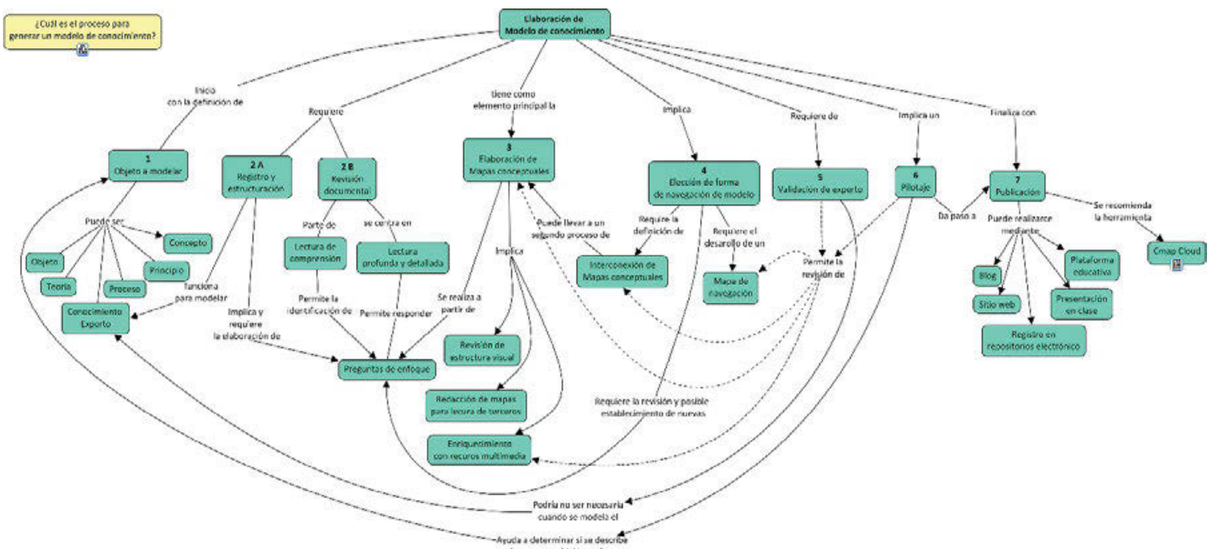

Figura 1. Mapa conceptual que explica el proceso de construcción del modelo de conocimiento.

4 Conclusiones

Los modelos de conocimiento son representaciones externas que se elaboran a partir de la comprensión y conceptualización de algún área de conocimiento basados en elementos teórico-conceptuales, que no solo representan la forma en que el/los sujetos estructuran su pensamiento (representación interna), sino que representan una organización del conocimiento que es susceptible de ser percibida por otros.

El proceso de elaboración de un modelo de conocimiento modifica la representación interna del o los sujetos que lo elaboraron, aportando nuevas estructuras en el proceso de construcción de conocimiento, por lo cual se puede considerar su elaboración como una opción para los procesos formativos de estudiantes y profesionales, siempre buscando la rigurosidad académica que permita garantizar el desarrollo del conocimiento.

Este trabajo presenta una metodología resultado de la recuperación reflexiva de un proceso de diseño y construcción de un modelo de conocimiento, sin embargo consideramos que se requiere implementar la metodología en nuevos contextos y documentar los procesos para encontrar sus inconsistencias, sus aciertos y mejorar la propuesta que aquí se hace, lo cual deja abierta la puerta a nuevos proyectos de investigación.

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CASE STUDIES AND EFFECTIVENESS OF A CMAPS ANALYTICAL METHOD

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Abstract. Analytical assessment of concept maps (Cmaps) using Fisher's exact test was performed to detect changes in high-school students' perception of scientific concepts in a science class. By counting the number of links between two words (concepts), AMCL (Analytical method of Cmaps with the increase and decrease of links) reveals whether the increase and decrease of these links are consistent with the results of Fisher's exact test, which uses 2 × 2 cross-tables for such calculation. I verified the effectiveness of AMCL using three case studies from high-school earth science classes: examining the fossil footprints of Akebonozou, a Pliocene elephant species (case study 1); studying the gravel debris paleoflow (case study 2); and investigating a caldera in Japan (case study 3). Links between two or three words (concepts) in Cmaps which correspond to various scientific concepts were selected and used in AMCL. Based on the case studies, the AMCL statistical analysis can be effectively used for detecting the tendency of different understandings of all students in the class.

1 Introduction

Concept maps (Cmaps; Novak and Gowin, 1984) have been used for detecting changes in perception. In Japan, since the 1980s, Cmaps have been used to evaluate the levels of understanding and knowledge obtained by a learner, supporting the teaching process. In addition, they have been used as tools to support collaborative learning with others, including a teacher. Moreover, various applications have been suggested by creating Cmaps using a computer. In the present study, the effectiveness of the AMCL method (Analytical method of Cmaps with the increase and decrease of links), developed by Taga et al. (2007), is investigated. The AMCL method enables the detection of changes in the perception of scientific concepts using Fisher's exact test based on the increase and decrease of the linkage of Cmaps. In the present study, the effectiveness of this analytical method is determined based on three case studies from science classes (Taga, 2008; Taga et al., 2009; and Taga et al., 2010), though Cmaps of this study are not Novakian.

2 AMCL Methodology

Generally, Cmaps presented at the beginning and end of a lesson can help students grasp changes in scientific concepts through comparison. However, it is difficult to grasp general transformation tendencies of these understandings as a whole, especially when there are many target students. Therefore, Taga et al. (2007) focused on linking two or three words in Cmaps. By counting the number of links (connection between these two or three words as one unit), they statistically analyzed the numerical change in understanding before and after the lesson (AMCL). The AMCL method is outlined as follows.

After performing Cmaps twice (i.e., before and after) by focusing on particular meaningful content before and after a class, the number of "word–word" links, which is considered as a proposition, is counted. Then, the increase or decrease is examined at a 5% significance level (two-sided test) using Fisher's exact test by employing a 2 × 2 cross-table. When the increase or decrease is significant at the 5% level, then the probability of the proposition with two or three concepts ("word–word" or "word–word–word") is assumed to increase. As a result, it is possible to infer the general tendency toward a change in perception by the entire class. AMCL is usable about the change of various propositions, and this report examines the effectiveness of AMCL.

3 Case Studies of AMCL Application

In earth science classes of Japanese senior high schools, the AMCL method is used for detecting changes in students' perception of scientific concepts. A student's Cmaps are shown in Figures 1, 2, and 3 and respective 2 × 2 cross-tables are shown in Tables 1, 2, and 3.

3.1 Case Study 1 (Taga, 2008)

Fossil footprints of Akebonozou, a Pliocene elephant species of Japan, were discovered in the Shiga prefecture, Japan (Research Group for the Fossil Footprints of Yasugawa, 1995). In junior high-school classes, the history of the ancient Biwa Lake layer, investigation method, classification of elephants, and formation of the fossil footprints of Akebonozou have been taught to students. Thus, students deepened their understanding concerning the formation of such fossil footprints. At the same time, students appear to comprehend concepts connected to sedimentation. To verify which concepts they understood, before and after a particular lesson, I recorded students' conception of a subject under study using Cmaps (Novak and Gowin, 1984). In particular, I focused on the increase or decrease of perceived links between different concepts regarding stratum formation. For verification, the conceptual system in which two or more conceptual labels are connected was used, i.e., "a footprint is printed on mud," "sand is deposited by heavy rain," "sand is deposited on the footprint," and "an alternation of sand and mud forms when sand and mud are deposited in turns." Furthermore, statistical analysis revealed changes in conceptual systems. After the class, each conceptual system considerably increased at the 5% significance level. This suggests that students understood the formation mechanism of the stratum in an alluvial plain in the context of the Earth's system.

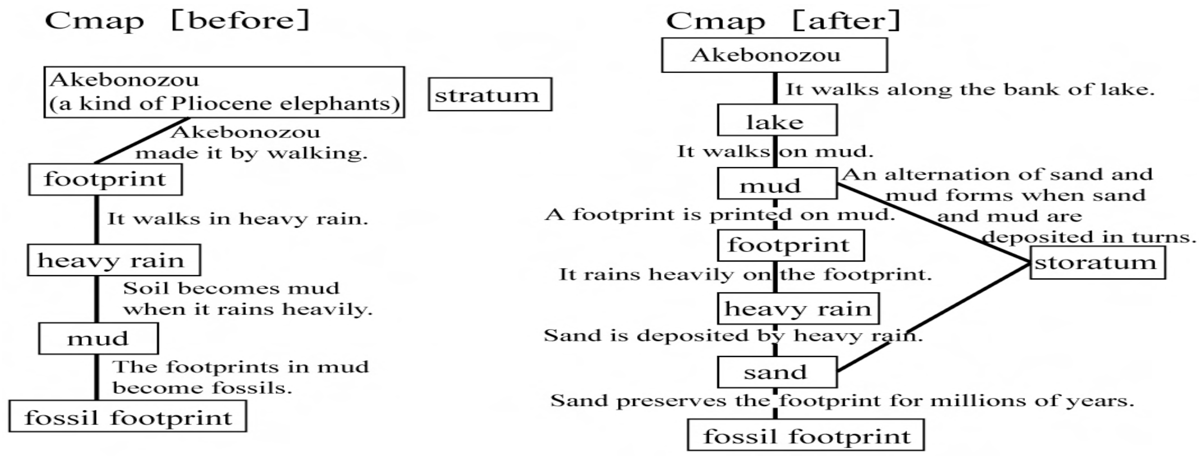

Figure 1. Student's Cmaps illustrating his/her understanding of fossil footprint formation before and after the lesson (Taga, 2008).

N = 23.

mud — footprint 「A footprint is printed on mud」	Number of links obtained	Number of links not obtained
Concept Map [before]	4	19
Concept Map [after]	16	7

p = 0.0008 ($p < 0.05$) meaningful increase

footprint — sand 「Sand is deposited on the footprint」	Number of links obtained	Number of links not obtained
Concept Map [before]	3	20
Concept Map [after]	17	6

p = 0.0000 ($p < 0.05$) meaningful increase

heavy rain — sand 「The sand is deposited by heavy rain」	Number of links obtained	Number of links not obtained
Concept Map [before]	0	23
Concept Map [after]	7	16

p = 0.0091 ($p < 0.05$) meaningful increase

mud-strutum-sand 「An alternation forms when sand and mud are deposited in turns」	Number of links obtained	Number of links not obtained
Concept Map [before]	5	18
Concept Map [after]	13	10

p = 0.0331 ($p < 0.05$) meaningful increase

Table 1: 2 × 2 cross-tables of the stratum formation process (Taga, 2008).

3.2 Case Study 2 (Taga et al., 2009)

Gravel debris flow in the Plio–Pleistocene Kobiwako Group, which is distributed over the southern part of Shiga, Japan, was observed during a practical lesson in high-school science classes. During this lesson, students compared the gravels of the debris flow with those from a river and discussed how the shapes of gravels were formed. I examined changes in students' understanding by AMCL (Fig. 2 and Table 2). Through the lesson, students' understanding of debris flow formation deepened. Therefore, this observation lesson was effective for understanding the debris flow.

3.3 Case Study 3 (Taga et al., 2010)

A practical lesson was conducted in a senior high-school earth science class on the analogue models of the Biwako Cauldron caldera, which is located in the southern part of Shiga, Japan. During the lesson, students observed the analogue models of caldera formation and discussed how the shape of the caldera was formed. Changes in the understanding of the lesson's contents by students were examined through Cmaps by AMCL (Fig. 3 and Table 3) and protocol in discussion and questionnaire method. As a result, students' understanding of the caldera formation process was enhanced. Therefore, the two observation models are effective in revealing the caldera formation process. Moreover, the discussion by students was significantly effective.

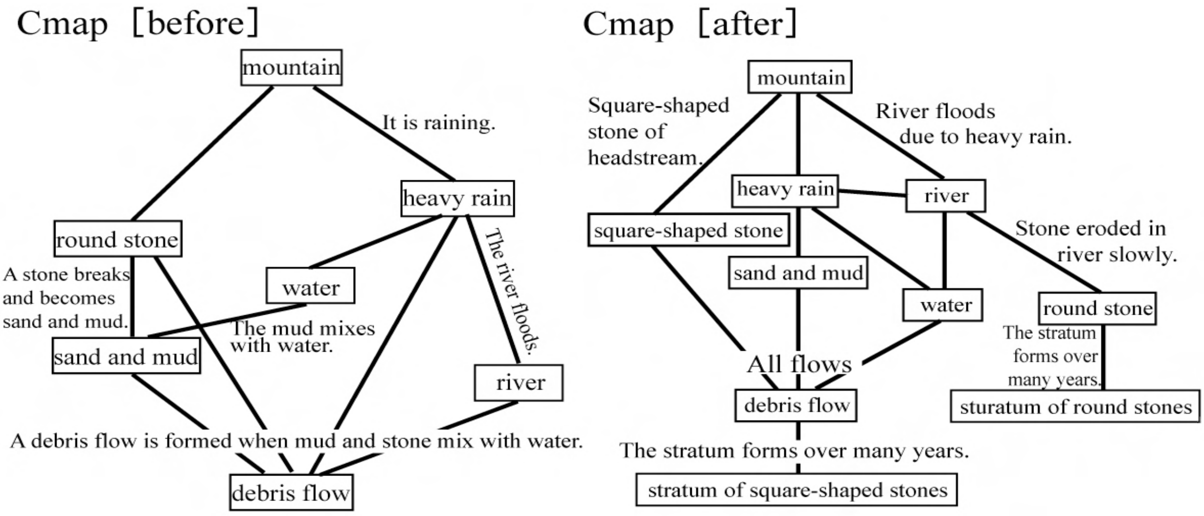

Figure 2. Student's Cmaps illustrating his/her understanding of debris flow before and after the lesson (Taga et al., 2009).

N = 71.

debris flow—square-shaped stone 「Square-shaped stone forms due to debri flow」	Number of links obtained	Number of links not obtained
Concept Map [before]	20	51
Concept Map [after]	52	19

p = 0.0000 ($p < 0.05$) meaningful increase

river—round stone 「Round stone forms due to river flow」	Number of links obtained	Number of links not obtained
Concept Map [before]	21	50
Concept Map [after]	41	30

p= 0.0012 ($p < 0.05$) meaningful increase

Table 2: 2 × 2 cross-tables of concepts concerning the debris flow process (Taga et al., 2009).

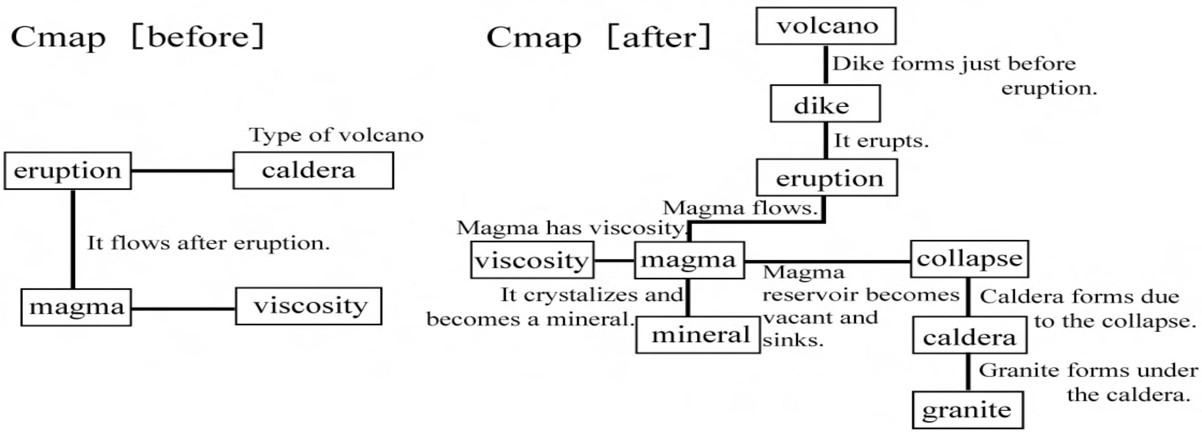

Figure 3. Student's Cmaps illustrating his/her understanding of the caldera formation process before and after the lesson (Taga et al., 2010).

4 Discussion

Novak and Gowin (1984) reported that "Concept maps are intended to represent meaningful relationships between concepts in the form of proposition. Propositions are two or more concept labels linked by words in a semantic unit. In its simplest form, a concept map would be just two concepts connected by a linking word to form a proposition." Therefore, the link connecting two labels is the simplest unit of a Cmap and corresponds to a proposition. The AMCL method can verify the increase or decrease of Cmap units.

N = 27.

eruption—dike 「It erupts through dike」	Number of links obtained	Number of links not obtained
Concept Map ［before］	2	25
Concept Map ［after］	9	18

$p = 0.0394$ ($p < 0.05$) meaningful increase

dike—caldera 「Caldera forms due to dike」	Number of links obtained	Number of links not obtained
Concept Map ［before］	2	25
Concept Map ［after］	9	18

$p = 0.0394$ ($p < 0.05$) meaningful increase

dike—collapse 「collapsed along dike」	Number of links obtained	Number of links not obtained
Concept Map ［before］	1	26
Concept Map ［after］	8	19

$p = 0.0243$ ($p < 0.05$) meaningful increase

collapse—caldera 「Caldera forms due to collapse」	Number of links obtained	Number of links not obtained
Concept Map ［before］	7	20
Concept Map ［after］	16	11

$p = 0.0266$ ($p < 0.05$) meaningful increase

Table 3: 2 × 2 cross-tables of concepts concerning the caldera formation process (Taga et al., 2010).

In the abovementioned three case studies, the number of links corresponding to propositions changes after a lesson. Thus, links in each student's Cmaps also change. Individual changes can be understood more easily than those of the entire group of students by comparing Cmaps before and after a lesson (Fig. 1, 2 and 3). However, general tendencies affecting the entire group of students are difficult to grasp. The three case studies provide evidence that the AMCL method can be used for statistically detecting these general tendencies. In the three case studies, new links were formed after a lesson, which did not exist in Cmaps before the lesson (Table 1, 2 and 3). These new links refer to new connections among concepts. This means that new propositions (scientific concepts) were formed and the AMCL method effectively detected this change. In this sense, the AMCL method would be an effective analytical method.

5 Summary

For detecting changes in propositions (scientific concepts), I verified the effectiveness of the AMCL method, which analyzes the number of links in Cmaps obtained before and after lessons. This conclusion was verified through three case studies of science classes in a Japanese high school. Results revealed that the AMCL method can detect changes in the tendencies of an entire study group of students.

6 Acknowledgements

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CONCEPT MAPS AND AUTHENTIC TASKS FOR A MEANINGFUL LEARNING

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Abstract. Teachers are feeling an uprising need to face the everyday problems of learning they observe in their classes: that's why they are making use of didactic strategies suitable with the context. To a former kind of learning, is counterpoised a meaningful one, in which the focus is put onto the student, on its previous knowledge and on its motivation to learn. At the same time, in a complex and globalized world, creativity, lateral thinking and enterprising spirit are being increasingly appreciated compared to more classical specific knowledges. An experience led in a third year class of secondary school is here reported, where the teacher has proposed a focus on sustainable food and hydro/ecological footprint of everyone's diet. Developing sensitivity and interest towards environmental issues is a priority for teenagers to become responsible citizens of tomorrow. These complex problems must be faced resorting to innovative didactic strategies, which make the student architect of his own learning by helping him to construct a life-linked meaning of the knowledge through assimilation mechanisms: we believe that authentic tasks and concept maps would be a valid tool to help them reaching this ambitious goal.

1 Introduction

In a similar context, building up concept maps in order to complete an authentic task, represents an highly stimulating didactic strategy to the students and gives them the opportunity of interpreting, organizing and restructuring the information coming from different environments of their lives (classroom, home, television, internet): we believe that this process is fundamental for them to face new situations autonomously.

2 Concept Maps Help Meaningful Learning

Meaningful learning can be simplified by the use of concept maps (both drawn with a pen or using a specific software): they represent a powerful cognitive tool, which support students find out key ideas and organise their knowledge.

On a first stage scholars make their own maps, which will later be shared with the other group members. After the debate phase, they all start working on group concept maps. The comparison phase is one of the most important since students are required to make a deal, realizing a map which would be representative of the cognitive styles of the whole group. Verbal communication has an important role: it allows the language to improve, becoming more and more specific and well structured.

2.1 Technologies and Meaningful learning

Technologies can sometimes be a support for meaningful learning: they are not used as a distribution vehicle of contents but as cognitive, collaborative, construction and sharing tools or as representation of knowledge tools. Such kind of support is given by CmapTools (Cañas et al, 2004) software (developed by the Institute for Human and Machine Cognition) which is provided to students since the first years of primary school. They build group concept maps using a versatile device such a as n iPad is: they are also able to work in a cooperative way at home, using Cmap Cloud, specifically created by the teacher. In this way everybody (students and teacher) can archive and share their concept maps anytime, anywhere and from any device they're working with.

2.2 The Authentic Assignment

The goal of an authentic assignment is to test student's ability in real (or almost real) operative contexts, proving their cognitive and metacognitive competences.

2.3 An Example of Authentic Assignment

2.3.1 Introduction

Every year in Italy, up to 8 millions of tons of food are thrown away: this amount includes still edible products that claimed energy, water and natural resources to be transformed and packed for the supply. Since this process takes place mainly in our houses, we believe that everybody should revise its own life style, for instance by purchasing food in a responsible way.

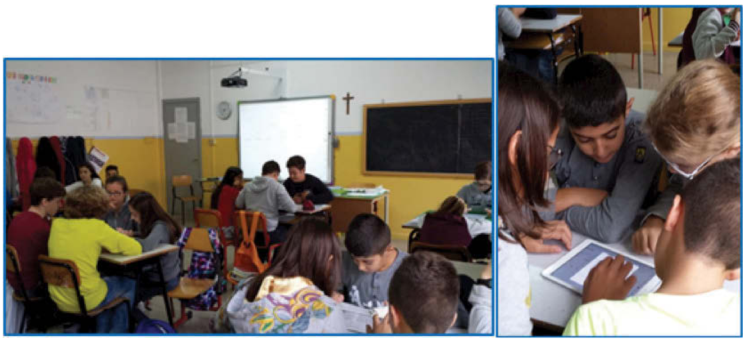

Figure 1-2. Students working individually or divided into groups, storing their maps on the Clouds. At home, they will then download, edit and share them: everything is tracked and available to the teacher.

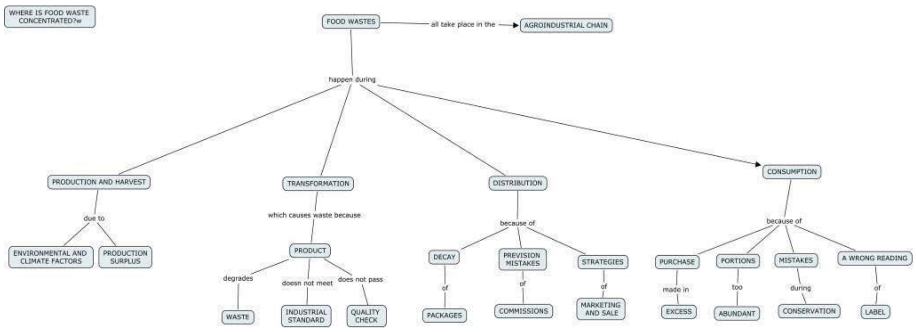

Figure 3. Example of a concept map, realised in group, shared by different groups simultaneously and stored on the Cloud.

2.3.2 The Assignment

"During the "International School Week of Cooperation" you have been asked to organize a public event, to attract children's and adults' interest on sustainable nutrition and food waste themes. You will now work individually and in groups: on every stage you will have to build a concept map that will help you defining the ideas you have received and link them together. Our school have made computers and IPads available to you, which you can use to realize presentations, multimedia games and concept maps."

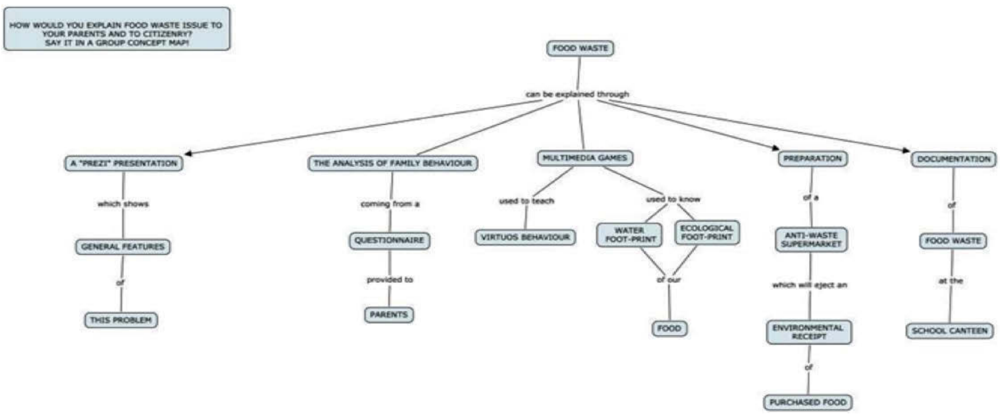

Figure 4. How can "Food waste" issue be explained? Proposals have been represented on a group concept map. All the maps have been posted onto the classroom's walls: it will encourage students to debate and compare each other's opinions.

2.3.3 Ways of Working

Class in firstly divided into six cooperative groups and a role is assigned to every member. They will have to work out how to organize the event day and represent their project idea onto a group concept map. All the maps have then been posted on the classroom's walls and explained by the respective group: this phase have been followed by a debate, aimed to get to a final concept map, which represented the core of the entire event. Seven cooperative groups are now formed, everyone with different tasks to complete.

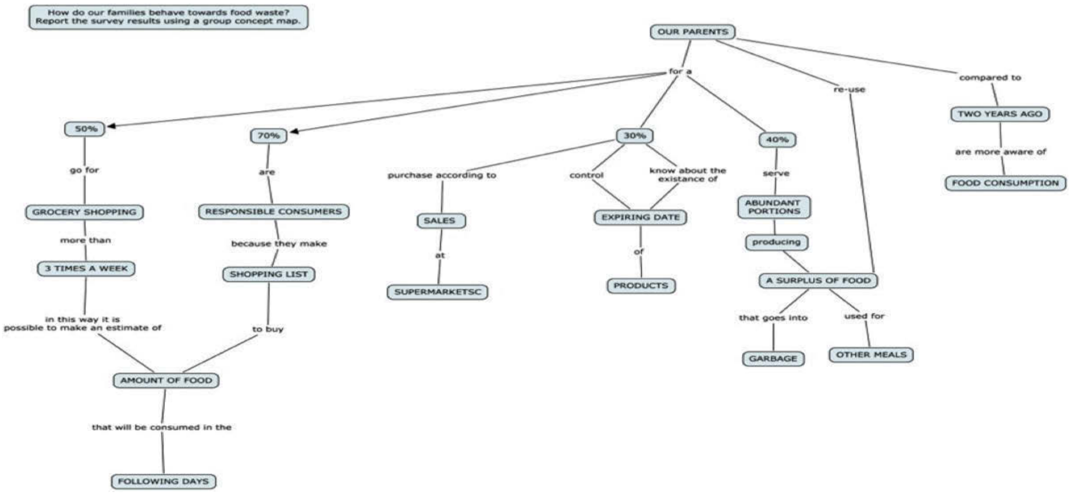

Figure 5. A questionnaire allows students see how their parents behave in relation of food waste. They use a concept map to communicate it to the classmates.

2.3.4 Resources

Every group is furnished with a short list of two/three websites indicating which information they were supposed to look for and where to find them.

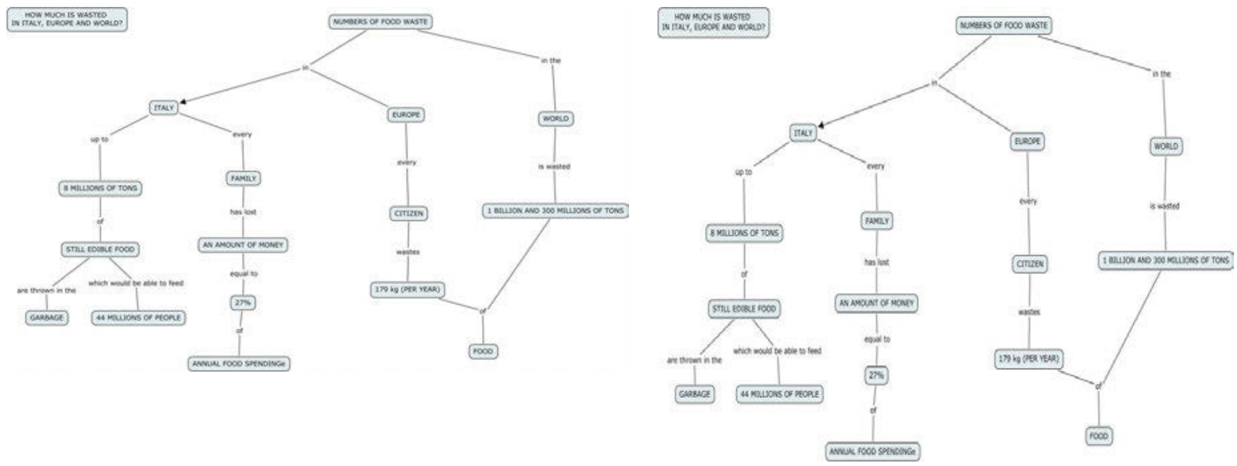

Figure 6-7. Students analyze the resources provided by the teacher, compare themselves to each other and build concept maps to organize their knowledges

2.2.5 Evaluation

Every group in equipped with:

- Student auto-evaluation questionnaire
- Group auto-evaluation questionnaire
- Evaluation section, in which every ability is verified using one of the following indexes (the applicable score went from 1 to 4):
  - Organization and team work
  - Participation and involvement
  - Information seeking
  - Final product elaboration

2.2.6 Conclusion

All the maps realized for this project have been exhibited in a showroom. Using concept maps to tell and explain the different stages of the experience has an high meta-cognitive value. The authentic assignment provided to the class is real, strictly linked to reality. The public event actually took place, turning out to be a real success in terms of participation and visitor's interest.

2.4 *The Teacher's Role*

The students' behaviour during planning and problem solving stages is carefully observed by the teacher, which eventually makes an evaluation of everyone's abilities and, at the end of the work:

- Considers auto-evaluation questionnaires (individual and common one);
- Evaluates single groups trough the "Evaluation section":
- Encourages his students to meditate on the work done, on gained knowledges and on the way they actually cooperated.

2.5 *Authentic Evaluation*

The evaluation has to be authentic and partially given by the students' auto-evaluation process, which ensures the relevance of the evaluation itself. In fact, it generates a deep understanding of themselves and promotes motivation-driven processes that support the development of the individual potentialities.

2.4.1 Analysis of the authentic assignment evaluation

Individual auto-evaluation of students

- 90% of students prefer carrying out group activities rather than in couple (10%);

Group auto-evaluation

- Most of the students have judged the work both interesting and demanding;
- The materials and amount of time provided have been considered sufficient to carry out the work;
- Decision making and collaboration turned out to be the easiest social abilities to respect;

Evaluation Section

- Evaluation section is helpful to measure and check the quality of the performance that teacher elaborates and introduces to the students.

3 Summary

Carrying out an authentic assignment and building up concept maps certainly help students to reach their educational success. Most qualifying elements are:

1. Cooperative environment of learning; concept maps and authentic assignment take place in a cooperative learning environment;
2. Solving real problems motivates students, since they are required to put into practice their creative abilities and critical thought;
3. Consciousness of the students in terms of what they know and what they still need to grow as a student and as a human being. Students are also aware of the reasons which brought them to receive a certain education and how they have had it.
4. The students have achieved a self-regulation of the learning process, since they have understood the importance of the knowledge and the uselessness of a coercive approach.

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CONCEPT MAPS AS A MEANS OF UNIVERSITY TEACHING ASSISTANT

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Abstract. Concept maps are a valuable resource to support teaching, especially when this are used through a computer network or Internet. In this paper the concept maps to teach various subjects of IT careers are used. Maps nodes have various resources that support the teaching-learning process, many of them let you run simulations as an effective way to teach events that are not visible to the human eye. The subjects of study are: Operating Systems, Computer Networks, Computer Architecture, Logic Programming and Data Structures. The systems use various resources associated with the concepts, among them include: Web pages, images, text, videos and simulations outlined above. The system used to teach data structures has the added value to display, dynamically, data and programs of an algorithm programmed in a language specifically designed for this system, while the system to teach logic programming add functionality to adapt to the knowledge of students by including a set of intelligent agents that control the process of teaching and learning.

1 Introduction

The use of computers to teach began in early history of computing, the practice can be cited back to Skinner's Teaching Machine (Skinner, 1958) and the PLATO project (Bitzer, Braunfeld, & Lichtenberger, 1961), along with other results from that initial era.

To analyze the effectiveness of some of the systems of first stage of computer-assisted instruction, (CAI) several studies were made. For example, Suppes and Morningstar conducted a classic analysis based on the traditional model of an experimental group against a control group (Suppes & Morningstar, 1969). The authors cite various analyses, linking other important studies of that time, which were intended to measure the effectiveness of the systems of that time.

Naturally, the first computer teaching systems were gravely limited by the hardware of that era and the lack of computers; however, it was always thought that computers could be utilized as an aid for teaching or a means for teaching.

Ausubel's learning theory emphasizes the importance of previous knowledge on a topic in order to learn new things; this is known as meaningful learning (Ausubel, Novak, & Hanesian, 1978) and it is achieved when acquiring new knowledge is related with previous knowledge which relates new knowledge to previously acquired concepts or propositions, and these are managed explicitly and consciously (Novak, Gowin, & Johansen, 1983). Meaningful learning is contrary to memorization, since the latter doesn't form these connections.

Concept maps (Novak & Gowin, 1984) form a learning strategy that organizes interrelated concepts, supporting the ideas of meaningful learning. When the maps are accessible via computer networks, they can provide teaching resources and are an excellent option that supports the constructivist model proposed by Ausubel.

In this paper, several systems using concept maps to teach various subjects in the computer area are presented, and the systems presented use computer networks as a means of communication. The subjects of study are: Operating Systems, Computer Networks, Data Structures, Computer Architecture and Logic Programming.

2 Overview

Concept maps basically represent meaningful relationships established between two concepts to form propositions or simplified phrases (Cañas et al., 2000). Each concept is linked by a word to another concept to form a basic proposition; it can also form more complex propositions when browsing the map.

There are several tools to build concept maps, in this work the Cmap (Cañas et al, 2004) system that uses client-server architecture was chosen; where the client side is the CmapTools (or any browser), while the CmapServer is server side and has the responsibility to meet the requests generated from the connected clients, usually remotely. The choice of the tool was based on its versatility and because it is free for educational institutions.

Maps built with CmapTools can stay on a remote machine that has installed the CmapServer server or you can use the cloud service offered by Cmap; in the latter case it is not necessary to install the CmapServer. In both situations the services work well, but if Web pages cascading style (CSS) are used, it will not, the use of CSS style is very useful because it allows separate structure and presentation of HTML, XML or XHTML documents (Duckett, 2011). For this reason, the systems presented in this article are managed from a server machine that has CmapServer as handler maps and all resources except the Web page that are managed by the Apache Web server.

2.1 Concept Maps as Teaching Support

The systems presented below were designed, advised or built by experienced teachers who relied on different degrees of student work, who had the responsibility to develop some of them locally. After a detailed review by the team, these were published with the purpose of being non-modifiable by learners; for that reason the students who use them are not authorized to make changes because the purpose is that learning is acquired when navigating well-designed maps, where the concepts and relationships that make up the propositions are true and they are formalized correctly. The systems are characterized by subliminal information that allows you to associate content covered with images showing background maps, or the header and footer of Web pages.

General aspects associated with all systems, such as colors and images that accompany each map should always be considered when a system of this type is designed. Moreover, it is very important to use simulations in the teaching of these subjects, because many of the processes that are studied are not visible to users and it is somewhat difficult to explain without adequate aid, the three systems that title this heading are aided in different simulations that fit each subject of study.

Each of the concepts or nodes in the map should be supported by additional information in the form of resources associated. We recommend using Web pages that give more beauty to what is explained and allow you to define links between different concepts, but too many link systems should not be used because students may feel lost when navigating. Simulations are also very useful because they allow students to appreciate invisible mechanisms that are difficult to explain verbally, which can be programmed in different languages.

The systems that were made following these ideas are called: SESO "System for teaching operating systems" (Garrido & Gonzalez, 2009), SERC "System for teaching computers networks" (Gonzalez, 2011; Brene, 2012), SEAC "System for teaching computer architecture" (Sori, 2011; Brene 2012), VIA-ED "System for teaching data structures" (Soler, 2009), APA-Prolog "System for teaching logic programming" (Ríos, 2009).

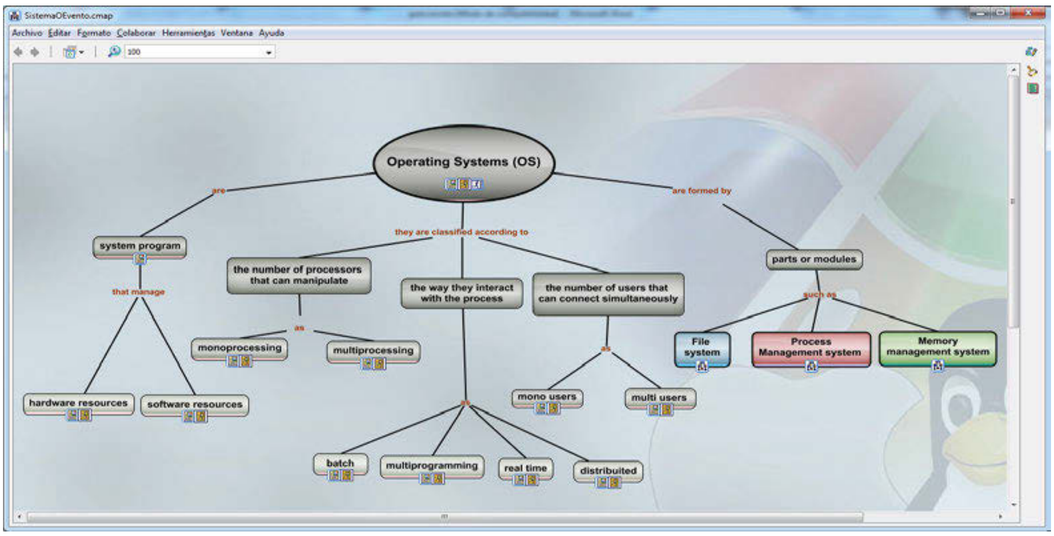

Figure 1. SESO System: main map.

Taking as an example the main map of the SESO system (Figure 1), you can see the graphic allusion to the three most used worldwide operating systems (Windows, Mac and Linux). It is observed that different colors are also used to distinguish three sub-maps that respond to three key modules of these systems, *the file system*, *the process management system, the memory management system*, each of these concept maps has a different color; nodes and resources derived from them must have the same color. Also, the background color of the sub-map should highlight the same color, albeit in different shades, in order to subtly remind the student what is being analyzed.

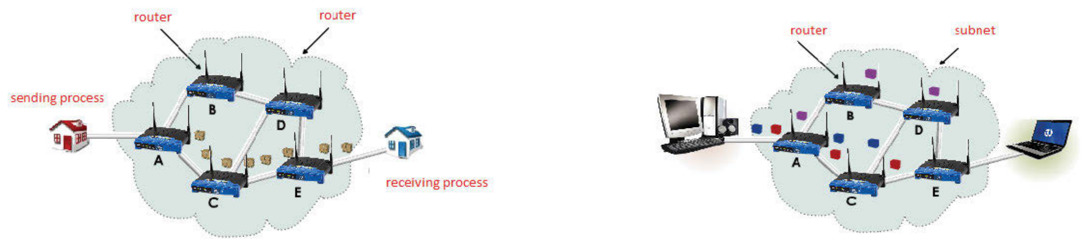

Figure 2. SERC System: simulating the transmission of a packet.

Figure 2 shows a simulation that is within one of the web pages of SERC system. The student reaches this simulation after having read an explanation about how packets are transmitted, the explanation is supported by various resources (graphics, images, etc.) displayed statically. At the end of the page the student can find and use the *play* and *stop* buttons to see how a packet is sent from a sender process to a receiver process. The packages on the left have taken the same route; while the packages on the right have followed different routes.

In Figure 3 one of the simulations SESO system can see. The simulation shows an example of a system that allocates memory spaces that need a process contiguously.

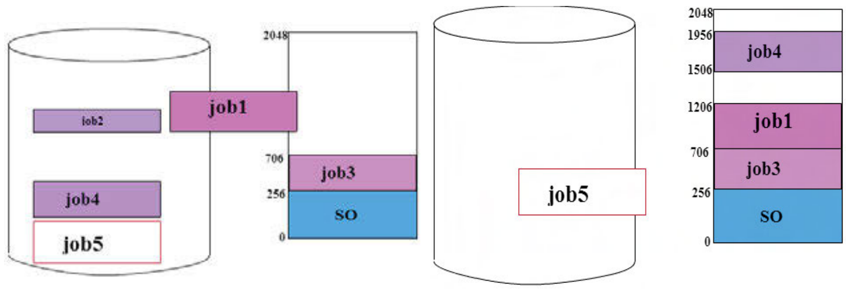

Figure 3. SESO System: contiguous memory allocation.

The simulation of figure 3 has been stopped in two instants:

- The left side of figure 3 shows the simulation when being loaded into memory a process called job1, the process called job3 had been previously loaded.
- The right side of the figure shows the moment when the OS is trying to load into memory the job5 process. The processes j3, j1, and j4 are in the memory at that moment. In addition, there are two non-contiguous free spaces which together could meet demand but as they are separated will not be usable.

Maps associated with VIA-ED system have resources similar to those discussed above and they are used with the same general design strategies of its components, but differ in one key aspect because it is based on three specially designed systems for this application (Soler, 2009): VisualProg a system to program visualization; SubC language and Pizal, a tool that can represent data graphically. The VisualProg system takes, as input, a program made in the SubC language.

The Pizal system can display the data structures associated with the program being analyzed, written in SubC, while VisualProg shows the program execution trace, all of which is very important during the learning process because students can appreciate the changes causing the code it is analyzed on the data structures used.

The APA-Prolog system is distinguished from others by being dynamic, which means that the elements associated with its nodes or concepts within the maps change according to the level of knowledge possessed by students who interact with the system. This is achieved by assigning the system a set of intelligent agents to control the behavior of resources (Ríos, 2000). The agents are:

- *Adis* performs an initial diagnosis to each student, based on several evaluative forms.
- *Tivo* offers students several links to additional information. His decision is based on identified deficiencies that are specific to each learner.
- *Teo* decides what theoretical materials are suitable for a particular student.
- *Tica* has the task of presenting practical activities, which are associated with the level of knowledge of each student.
- *Eva* is responsible for evaluating the student and deciding whether or not to change their state of knowledge. If it does decide to do so, it modifies and places them in epithets of values: good, average or poor.

3 Summary

Concept maps are a powerful tool to support teaching, their application in systems with client-server architecture provide students resources that are available at all times. They only need a network connection between the machine where the student resides and where the servers are (Apache and CmapServer, in this case).

Maps acquire greater value when you add learning resources that offer different ways of presenting the contents. Many of the problems studied in computer specialties are not visible; in that case simulations are an extremely valuable resource and learning assistance for discoveries.

The VisualProg and Pizal systems, coupled with SubC language, are an appropriate means for the study of programming, because the former allows showing the student the execution trace of a program written in SubC; which can be designed according to a target specific study, while the latter displays variations experienced by data structures used in the program.

The idea of using intelligent agents to teach, as is done in the APA-Prolog system is very useful for adapting teaching to the students' abilities, so everyone goes at the pace that suits their characteristics.

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CONCEPT MAPS AS A TOOL TO MAKE A SCIENTIFIC EDUCATIONAL VIDEO, IN COOPERATIVE LEARNING

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Abstract. This work describes how a documentary video, about a scientific experience in cooperative learning, was made coordinating different work phases across concept maps creation and sharing among the project's stakeholders.
The video illustrates how to explain the fluids pressure concept to a 5th elementary class presenting a scientific experiment and using the cooperative learning method. The maps' graphic simplicity and conceptual clarity encouraged knowledge exchanges among the working teams overstepping geographical distances to produce a video to train teachers in cooperative learning method. The ideas are shown and connected to each other by a tool that is immediately readable and easy to improve.
In conclusion we can say that concept maps are a valid and low cost tool for knowledge sharing, shots arranging and video producing.

1 Introduction

The result of this work tries to highlight the precious influence of concept maps in order to achieve what we intended: creating a scientific educational video in cooperative learning. The video is supposed to be used by INDIRE in Florence (i.e. Istituto Nazionale Documentazione Innovazione e Ricerca Educativa) in the European project of PON "Scientific education" and directly involved a 5th grade of I.C. "King-Mila" in Turin. Such a setting permits to review the proposed activity analyzing and correcting potential errors. The scope of this project is exposing an example of teaching creating learning opportunities for teachers. The assumption is that through fieldworks teachers will convert theory into practice by being exposed to concrete images of teaching strategies: cooperative learning.

Preparing the video was a very complex procedure that required the integration of different resources from different parties: researchers of INDIRE, teachers of the 5th grade, a project "Parole della Scienza" expert, and technicians who carried out recording and editing. Such difficulties generated the problem of managing interdependence and interactions with different opinions. Concept maps tied our ideas to one another, shared and organized them over the distance, such a choice allowed us to use a graphic modeling to express our concepts synthetically. Furthermore, these maps supported communicative settings in our experience.

The map structure on fig.1 was created by the authors of the video at the end of the experience to explain the architecture of the path that leads to the video that involved the participants.

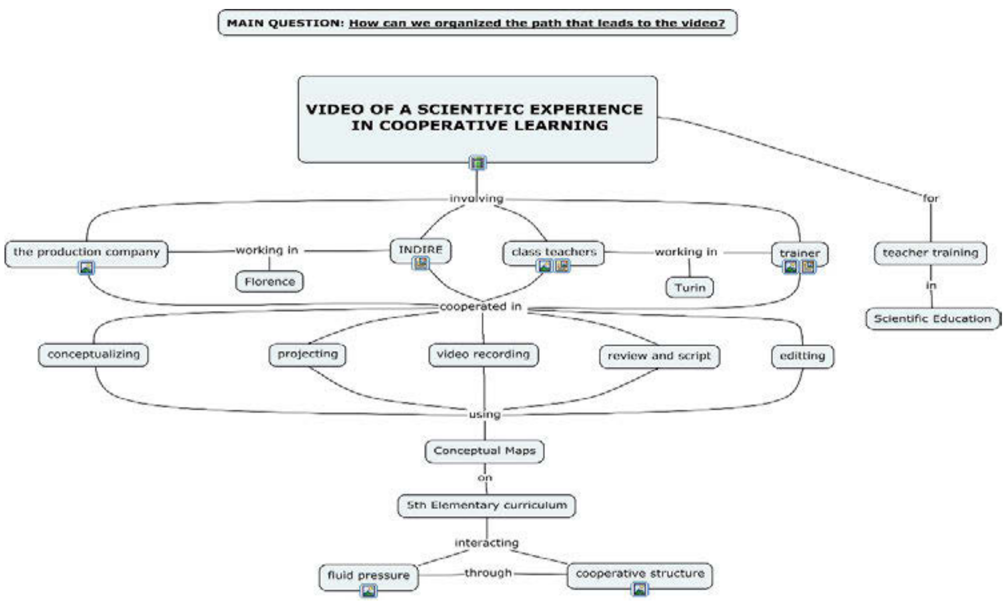

Figure 1. Concept maps of the video was useful in helping the director to get an incisive editing.

1.1 Theoretical Frameworks

The object of the video is to show how teaching science in an elementary school class can be carried out by cooperative learning. As it has been proposed by David Ausubel, learning can happen through reception or through discovery: in the first case, information passes through teacher to the pupils, leading the latter to be passive. However, on their own and through the teacher's guidance figure, the pupils achieve to discover the encountered concepts. Confirming Ausubel, Novak believes that "meaningful learning is opposed to rote learning and refers to a learning way where the new knowledge to acquire is related with previous knowledge." The latter can also incorporate new information into the pre-existing knowledge structure but without interaction. Rote memory is used to recall sequences of objects, such as phone numbers. However, it is of no use to the learner in understanding the relationships between the objects.

According to what has been proposed by the authors, we decided to propose a lab activity in which the students were active subjects in the proposed experiment, through controlling and direct observation. The pupils have elaborated the hypothesis and predictions to explain the observed experiments and to verify them empirically. The teacher was a guide who provided pupils with stimuli and encouragement throughout the entire process, a learning facilitator; they were protagonists in this process because they were actively involved in the experiments. The scientific concepts, taught through concrete experiences, allow a real construction of knowledge for the pupils. Constructivism is the base to ensure that learning will be stable throughout the time. Through such inquiry learning approaches, we put students into situations that demand critical thinking and encourage the internalizing of major concepts. Inquiry activities also give students the opportunity to express, confront, and analyze preconceptions and misconceptions in an active way. Robert Karplus proposed and used an instructional model based on the work of Piaget. This became known as the "Learning Cycle". To explain this theory to the different parties the teachers and the expert created a concept maps below.

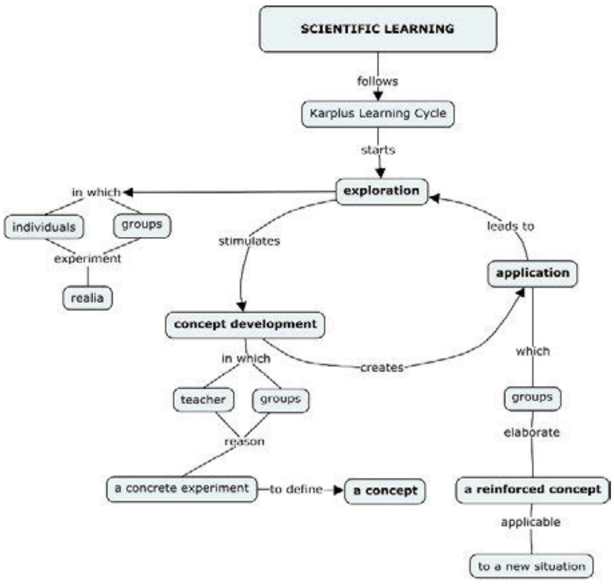

Figure 2. Karplus Learning Cycle.

Carl Rogers emphasizes motivation to be central in learning: "A person learns significantly only those things that are perceived as being involved in the maintenance of or enhancement of the structure of self".

The method used for the experiment was the Cooperative Learning that takes the students as the main source throughout the learning process. The cooperative learning class is divided in pairs and groups who meet with what the teacher puts forward, discussing it, experimenting it and observing it. Through a lesson under cooperative learning, all pupils think, speak and participate actively and in the meanwhile contribute to knowledge construction.

2 Methodology

2.1 The video creation through concept maps

The video was recorded in January 2015, in a Fifth Grade Elementary School in I.C. “King-Mila” in Turin. The teachers, beside Prof. Falasca, elaborated the activities and programmed the way to conduct them in class. In order to clarify things further, some concept maps were built up through which the activities and the content of the video were displayed. For example, the map of figure 2 was sent by e-mail to researchers to explain the application of Karplus Learning Cycle in the class. The map was a precious resource to connect theory and activity. The other map was particularly important to describe and schematize the class setting, to help the video technicians figure out how the class was arranged as for desks, student movements in order to ease the recording process. The diversity of the work environment made necessary to introduce the characteristics of a cooperative class and a detailed description of various moments of a scientific experience. As you can see in the fig.3, the class was divided in groups, each of which consisted of pairs who fully independently moved their desks to provide spaces. Then, cooperative roles were assigned to each of them: the Voice manager, the Time keeper, the Materials manager and the Presenter.

In order to create a relaxed and collaborative environment, the students applauded themselves, taking into account that the working day would be long and hard. Each pupil puts forward one's particular skills to provide the proper peer with the necessary support.

Figure 3. Cooperative roles.

2.2 The scientific experiments and the cooperative structures

In the first part of the activity, the materials were delivered to the pupils who were in charge of distributing them, while making them take turns in order to experiment first-hand and observe their peer. Emotive involvement is extremely high in both work phases. Through the moments in which they have to reason and reflect, the possibility to talk and face with a peer over the experiment gives them the chance to improve their lexical and dialogical capacities. Thus, they feel encouraged to build up hypothesis and predictions and verify them with their experiments. For the first experiment the pairs blew a balloon; We immediately asked the groups: "Why did the air you blew caused the balloons to blow?" Thus we asked the pupils to push the balloons slightly with the cardboard to observe how it deformed and how the air inside moved. At the end of this experience we asked the class to create a concept map to be used to describe the concept of pressure, starting from the examined events. The result comes from the pupils’ cooperation, who summed up and reworked the experience in order to formulate and learn the concept more easily. Using concept maps as a tool to re-elaborate the experiment, helps pupils to rearrange thoughts about the examined concepts.

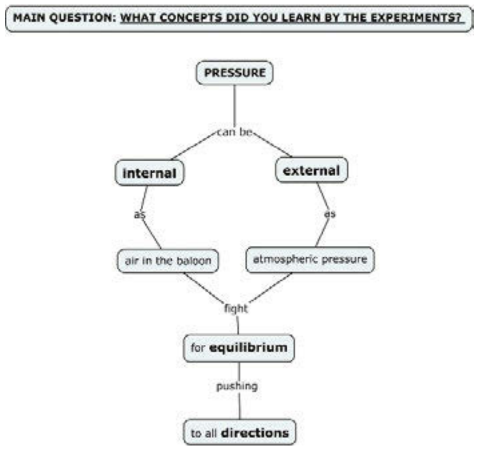

Figure 4. Map designed by a group of pupils.

For the second experience, we used a hotplate and an erlenmeyer flask with a balloon inside. In this case, the teacher conducts the experiment and the pupils are observers. Once the hotplate was hot enough, we placed the erlenmeyer flask on it. We observed the balloon blowing again on the external side of the flask and to allow the metacognition we used the *Placemat* cooperative structure.

The last request was to write a post-it about the satisfaction in the activity, expressing it through a short sentence or an emoticon. In the cooperative class, the focus is developing social skills, teaching them to reflect upon their emotions and discussing them with each other. In order to work together, it's essential to learn to negotiate over one's own believes and mediate, thus reaching group decisions or group responses. This element is an important purpose of the video.

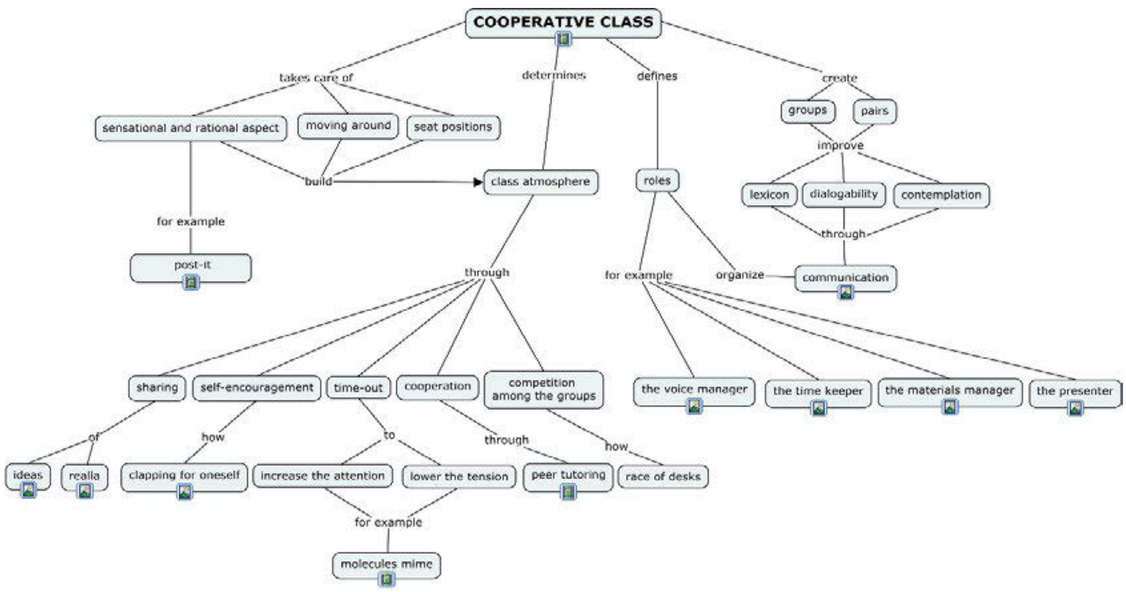

Figure 5. Concept maps of peculiarity in a cooperative class.

The map shown in Fig. 5 has been the guide to video editing. The technicians used it to highlight single elements of a cooperative class; thus marking the methodological characteristics of the activity. Another important part of collaboration with INDIRE researchers was programming single scientific experiments. Concpet maps were a helping hand in this step as well, facilitating the schematic representation of an activity, describing the methods through which experiments were proposed and the cooperative structures to be used for reflections. Organizing activities in this way made easier to exchange ideas among those who were laying out the project, by allowing the researchers to create a clearer mental image of what would be going through the class during the recording, supported by the graphic scheme of the map. Furthermore, it allowed us (i.e. the teachers) and Prof. Falasca to organize different steps of the experiment in a better way.

3 Conclusions

This experience produced a video for teacher education and represents a way of laying the cognitive groundwork for developing teacher self-reflection.
You can watch the video on the website http://repository.indire.it/repository_cms/working/export/6684/. It aims at training newly hired teachers, who can find here an example about how to set up a science class in cooperative learning.

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CONCEPT MAPS TO STUDY THE GEOGRAPHIC ENVIRONMENT

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Abstract. The proposed educational model comes from a multi-year experimentation that refers to the geography curricular program addressed to the students from the second biennium of the elementary school (9-10 years old). The teachers took advantage of the methodological lines of a science innovative project that identifies the student as a protagonist during his learning process, through the problem solving method that includes the phases of exploration-invention-discovery. The concept maps were, during the years, placed across the path developing it and becoming a meta-cognitive tool for the students. The use of "key-words" and "link-words" has helped the transformation of the knowledge in skill and the generalization of the concepts. The beginning point has been the everyday life of the students with some educational trips around the territory, enriched by the presence of an environmental expert and by the organization of some activities, using the cooperative method, to promote the motivation and prepare the children for an accurate and conscious observation. The material and the data collected are reported in class and re-elaborated together, first for a global vision of all the aspects of the territory (landscape). Follows an analytical approach of study and research, to catch the typical elements of each geographical environment and their relationships. The elaboration of the "geographical knowledge" is linked to the "scientific-biological knowledge" and the "historic-knowledge". The students are constantly stimulated to the construction of connections cause-effect and space-time.

1 Introduction

The students, that have experimented this project, live in a seaside resort in the region of Marche (Italy), where the basic geographical environments (rivers, mountains, hills, plains and the sea) are present.

The geographical element, that allows to catch the communion of the environments, is the landscape, as part of the territory seen from the top. The accurate observation of the landscape creates curiosity and stimulates questions that we can only answer by intuition and through our studying. On the basis of that, we give emphasis to the geographical space not as static, but as a developing element.

Developing the skill of observing a landscape allows students to become aware of its importance, because of its historical uniqueness and that the actions occurring in the present, will have effects in the future. Our sense of belonging to a territorial system will make us more responsible towards the environment and the living people.

2 Objectives

The educational-didactic project aims the following objectives:

- Consolidating the concept of "territorial-landscape system", its elements and dynamics.
- Acquire the skill to analyze and discover the inner and external relationships with other systems.
- Discover the men-to-environment connection and point out positive and negative aids.
- Establish man's responsibility towards himself.
- Sharing sustainable method.

3 Operative Phases

3.1 Exploration

For the realization of the educational-didactic project these are the operative phases:

It is the most involving time for the students, both emotionally and intellectually; for this reason, it has to be prepared accurately by the teachers with the cooperation of an expert.

The exploration has been done under two different approaches in two different trips:

- The landscape: the students have been taken to the hills, on a tactical position that gave the possibility to catch the view of the full extension of the valley, from the sea to the mountain, passing through the city, the land crossed by the river and the hills. The guided observation takes to the analysis of the basic geographical elements and stimulates reflections on why and how they were modified through the years. Thanks to this activity the children, that often "see but do not observe", had been led to reflect on the features. In class, with the support of photos, the landscape has been represented with graphic-pictorial process, chosen by the teacher.

- The specific geographical environment (for example: hills, sea, …), on the territorial range, represents a significant goal. During the trip the children observe the particular elements, collect materials, are involved in sensorial activities, organized in small co-operative groups, actually they look like real "explorers".

3.2 In Class

The teacher organizes the lessons that are useful to resume the data taken from the experiences and develop them according to the following levels:

- Geological aspect: environment origins according to the Earth history.
- Atmospheric conditions: arrangement of the territory on the climatic area of reference.
- Abiotic elements: the "geography words" are used to describe what the students have observed.
- Biotic elements: flora and fauna.
- Detailed study: with the support of pictures (also from some satellites), and/or videos, maps and specific texts, it's possible to proceed to the generalization with a particular attention to Italy.

In this phase some drawings, descriptive texts, charts, diagrams, plans and geographic maps are produced. The use of an appropriate and specific vocabulary provides an educational and didactic stimulus, re-elaborated and generalized according to the experience, assuming a didactical and educational value.

3.3 The Concept Map

Through this didactic methodology, the "concept map" is used to make up the significant learning process which involves the emotional apparatus and works on the cognitive one, enriching the latter. The elaboration starts from some key-words referred to: description, origin, biotic and abiotic elements, anthropic ones too. Through some key-questions we move to the link-words.

Here are some examples:

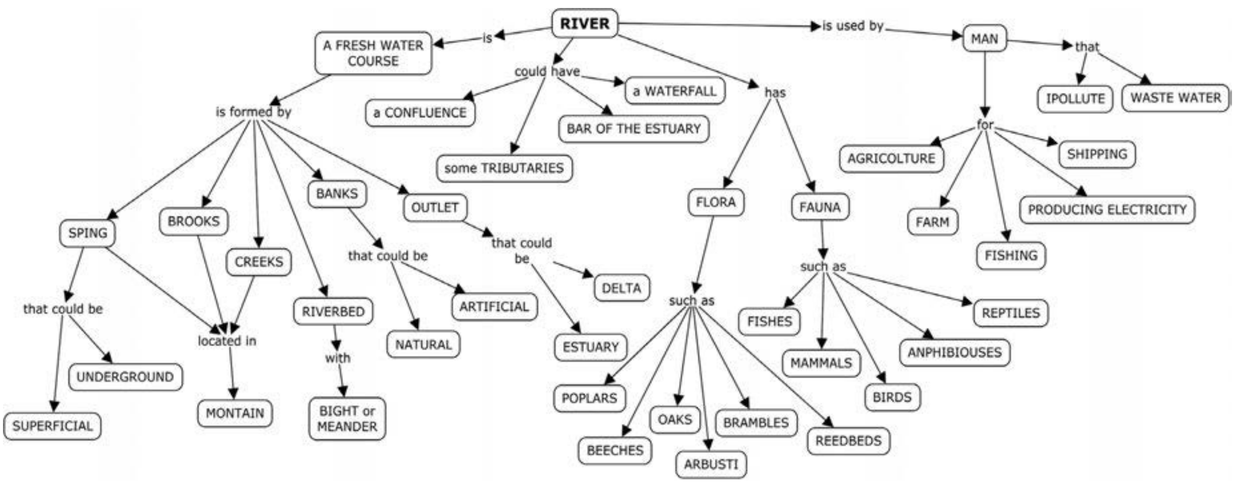

Figure 1. The resuming map of the geographical environment RIVER.

For example, in Figure1, the concept map is used for the final synthesis of the environment. It results particularly functional for the re-elaboration and for the individual studied, also for a long time.

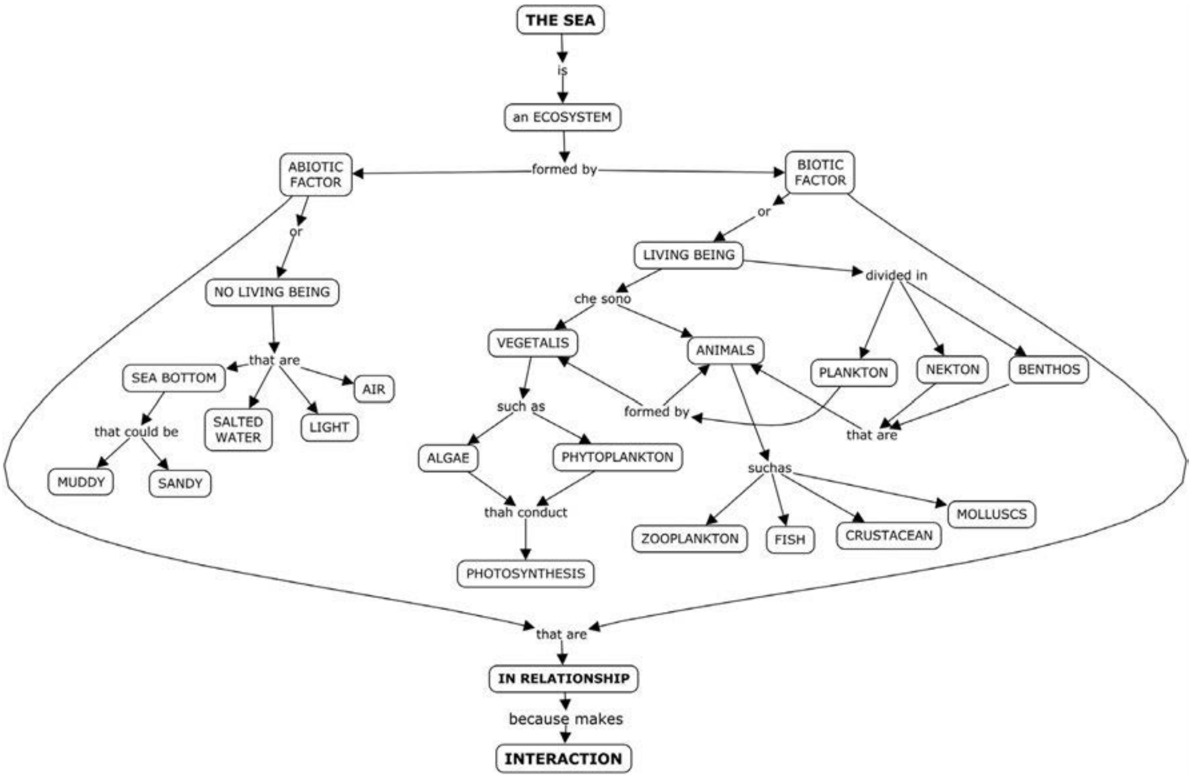

Figure 2. Geographic-scientific map of the SEA.

In the example of Figure 2, the concept map has an inter-disciplinary value. The hierarchy of the concepts highlights " the ecosystem", a biological nucleus, that is better called like the chlorophyllian photosynthesis. The "geography words" in the map are functional to the analysis of the macro-concept "sea-ecosystem".

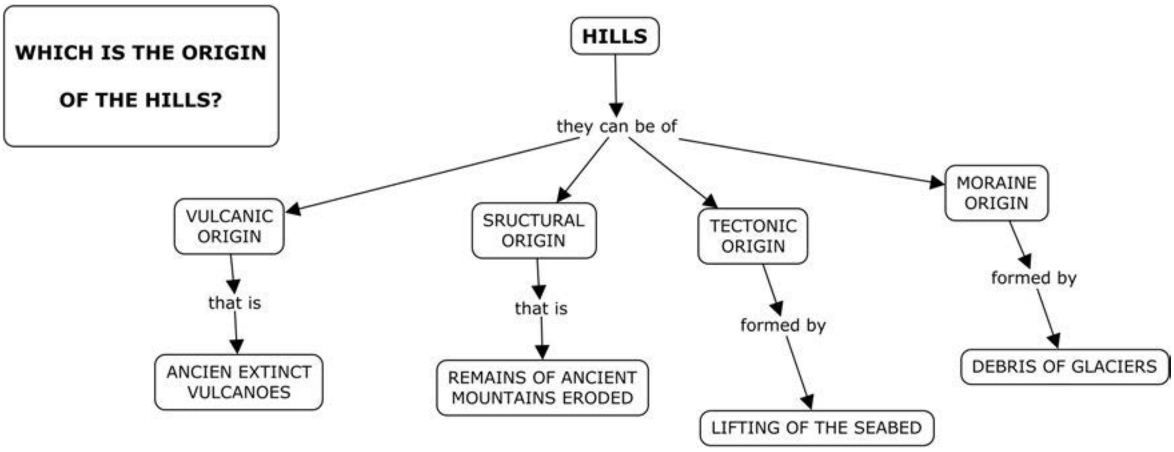

Figure 3. Map with a stimulating question about the origin of the HILLS

In the example of the Figure 3, the map is used to study a topic segment, as it is shown by the stimulating question.

Control and documentation of the learnings:

CHECK ON THE STUDIED ENVIRONMENT	
1° Level: Knowledge \ skills	**Checking method**
Geological aspect Abiotic elements Biotic elements: flora e fauna Anthropic elements	Oral exposition , with the support of a geographic map, pictures, diagrams, maps … Structured tests Participation to the activities and conversations: interventions in terms of analysis, reflection e critic
2° Level: Competence	**Checking method**
The landscape analysis	In a real context the student individuates the features that characterize the environment and picks up the main transformations made by the man, expressing himself using a specific language

4 Summary

The didactic scheme was experimented by the students of the school fourth grade classes, since the academic year 2000-'01 until the 2015, it has involved over 690 students, that have made more than 2500 concept maps, using paper and/or the CmapTools software.

According to the "national information for the elementary school and first level of educational system curriculum" (2012) it's possible to declare that the proposed model puts the student "at the center of the educational action in all of its aspects: cognitive, emotional, relational…" and results to be a project "not for abstract individuals, but for people who live here and now, that discuss over specific existential questions, that look for meaningful horizons". The knowledge of the territory, as it was realized, generates the transmission of the traditions and the national memories, enriches the experience and stimulates the curiosity. In the end, helping to the formation of the European citizens and members of the world, the school become "the place that combines the present reality to the past and the future", in the twine between memory and project.

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CONHECIMENTO PEDAGÓGICO DA AVALIAÇÃO DE MAPAS CONCEITUAIS: COMPETÊNCIAS (EPISTEMOLÓGICAS E METODOLÓGICAS) NA APRENDIZAGEM SIGNIFICATIVA

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Resumo. A combinação de alternativas de avaliação tem aumentado em cada conferência do CMC (Conference on Concept Mapping) revelando intensamente a atmosfera das inovações constantes, em cenário polissêmico e assimétrico, nas últimas décadas. Tais aspectos, tem requerido das produções acadêmicas apresentadas, novos modos de pensar o processo de avaliação. Os conhecimentos pedagógicos podem ser integrados de forma construtivista para fortalecer a aprendizagem significativa. Este paper identificou as diferentes dimensões de avaliação, nas produções dos anais da VI CMC realizada em Santos-Brasil, em 2014. Utilizou como metodologia a própria estratégia de mapeamento conceitual para demonstrar a posição educacional assumida pelo *design* de avaliação nos papers analisados. Destaca como resultado as singularidades e complexidades do processo de avaliação bem como as tendências e novas perspectivas relacionadas ao mapeamento conceitual. Os mapas conceituais são, definitivamente, "prática de investigação" permanente que expõe a natureza coletiva da avaliação, o envolvimento de pessoas diferentes e ampliam as possibilidades de compreensão e ação no processo de aprender e de ensinar. As diferenças em um processo de avaliação necessitam ser colocadas em relação dialógica e não somente em uma escala de categorizações.

1 Introdução

Para avaliar um mapa conceitual, alguns questionamentos surgem, o que é um mapa conceitual adequado? Como avaliar um mapa conceitual e quais são as adequações? A literatura na área tem avançado e os pesquisadores têm produzido pesquisas para responder estes questionamentos (Novak & Symington, 1982; Edmondson, 2000; Kinchin, 2000, 2001).

Cañas et al. (2015) apontam a complexidade de um processo de avaliação. Em que consiste a qualidade de um mapa conceitual? Quais as contribuições para uma aprendizagem realmente significativa? A estratégia de mapeamento conceitual favorece as possibilidades de avaliar muitos critérios individuais e de pensamento colaborativo diferentes, mas parece complicado determinar se um mapa conceitual é "excelente", nível 3. Outros trabalhos na área apontam se um mapa é bom ou não, classificando-os em nível 1 e 2 (Cañas, Bunch, Novak, & Reiska, 2013). Para entender a complexidade da análise dos mapas conceituais, Cañas et al. (2015, p.17) comentam que um "excellent concept map is like a good poem, we know when we have read one, but we can't quantify the reason. Professional Cmappers can recognize them, but it's hard to teach how to construct them".

2 Objetivos

Mapear e apontar os aspectos conceituais e metodológicos do processo de avaliação de aprendizagem envolvendo mapeamento conceitual por meio de revisão de literatura.

3 Metodologia

A análise temática sobre avaliação foi efetivada em 67 (full papers) com a revisão da literatura nacional e internacional nos *Proceedings* da VI Conferência sobre Mapas Conceituais em 2014 (Santos, Brasil). As categorias descritivas da revisão priorizaram as bases epistemológicas e os cenários de avaliação.

Uma visão geral sobre as produções mostram o Brasil com 30 produções, isto é explicado pelo fato do CMC 2014 ter ocorrido no país; em segundo lugar aparece o México, com 09 publicações e em terceiro a Espanha, com 06 publicações. Para selecionar os artigos, foram mapeados os títulos, os resumos e as palavras-chave das pesquisas que apresentaram um dos termos: "Avaliação, Evaluation, Assessment e Evaluácion". Desta seleção foram identificados 10 papers que abordaram o tema.

Foi elaborado um Mapa Conceitual que ilustra os cenários de avaliação descritos nos papers analisados, conforme Figura 1. Tais cenários focalizaram os conhecimentos pedagógicos (base epistemológica), as estratégias e recursos (base metodológica) e os cenários de avaliação encontrados na revisão dos papers.

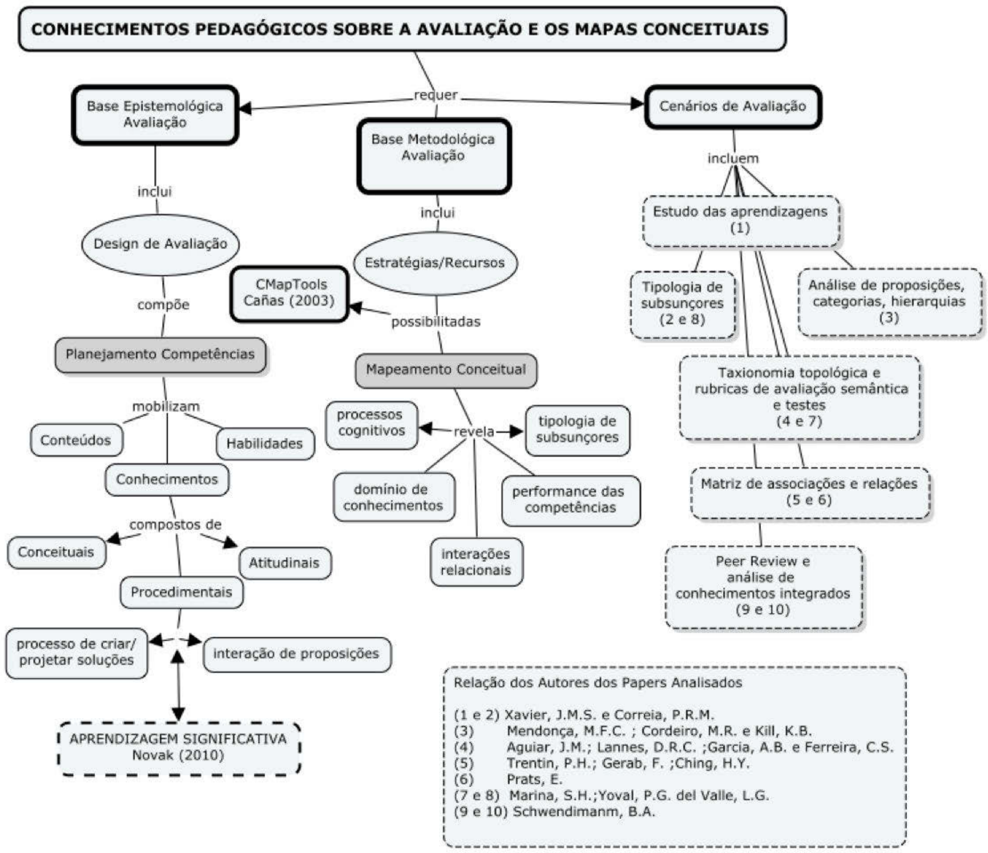

Figura 1. Mapa conceitual - conhecimentos pedagógicos sobre a avaliação e os mapas conceituais.

4 Os Conhecimentos Pedagógicos sobre Avaliação sob a Perspectiva de Mapeamento Conceitual

As análises realizadas permitiram visualizar os cenários de avaliação e as bases metodológicas apoiados pela estratégia de mapeamento conceitual. Os resultados das análises efetuadas foram fundamentadas pela Teoria da Aprendizagem Significativa (Novak, 2010) que inclui um designer de avaliação composta pelo planejamento de competências que mobilizam conteúdos conhecimentos e habilidades no processo da aprendizagem. Os papers descreveram processos cognitivos, tipologia de subsunçores, domínio de conhecimento, performance das competências e interações relacionais. Segue a categorização dos temas e seus respectivos autores: a) Estudo sobre aprendizagem (Xavier, J. M. S & Correa, P. R. M.); b) Tipologia de subsunçores (Xavier, J. M. S & Correa, P. R. M.; Marina, S. H. et al.); c) Análise de proposições e hierarquias (Mendonça, M. F. C.; Cordeiro, M. R. e Kill, K. B.); d) Taxonomia topológica e rubricas de avaliação semântica (Aguiar, J. M.; Lannes, D. R. C., Garcia, A. B.; Ferreira, C. S. e Marina, S. H. et al.); e) Matriz de associações e relações (Trentin, P. H.; Gerab, F.; Ching, H. Y. e Pratz, E.) e f) Peer Review e análise de conhecimentos integrados (Schwendimann, B. A.)

5 Resultados

Nas análises realizadas, de forma geral, há um direcionamento a um processo de avaliação que tem por princípio a produção de uma hierarquia de classificação e seleção de associações e relações sobre perspectivas quantitativas. De acordo com estudos de Esteban (2003) para quê classificar, selecionar e quantificar as aprendizagens? Para incluir os melhores classificados e excluir os piores classificados? Se existe preocupação efetivamente com uma educação de qualidade para todos, o princípio não pode ser apenas esse.

A estratégia de mapeamento conceitual permite exatamente representar o design de avaliação do processo de aprendizagem. Requer uma base epistemológica e uma base metodológica como o suporte do CmapTools que favorece a dimensão reflexiva sobre a aprendizagem, sobre a ação docente porque projeta possibilidades de direcionar as intervenções pedagógicas.

Os estudos investigados demonstram a complexidade de um processo de avaliação que tem como referência os caminhos de aprendizagem dos estudantes (sinuosos, heterogêneos, indefinidos e imprevisíveis). Tal complexidade no desenvolvimento da aprendizagem significativa não pode ser desconsiderado. Os valores negativos de um processo de avaliação que priorizam escalas métricas, hierarquia quantitativa de categorias, subcategorias e /ou classificação de proposições, não estimulam os valores positivos que marcarão as inovadoras transformações no ensino.

Uma das maiores contribuições dos mapas conceituais é a oportunidade que tal estratégia oferece a todos, grandes possibilidades para desenvolver uma dimensão reflexiva ou investigativa na avaliação. Potencializa o processo educacional, numa projeção de futuro. Nesse sentido, parece que é fundamental compreender que é consensual a ideia de que avaliar vem de atribuir valor, portanto, é preciso recuperar-se uma reflexão não só sobre os procedimentos utilizados como também planejar sua fundamentação epistemológica. Os recursos e estratégias trabalhados no processo de avaliação orientam, tanto o professor quanto os estudantes, na percepção dos processos cognitivos, no domínio de conhecimentos, na performance das competências e expectativas de auto-regulagem de suas aprendizagens.

Convém ressaltar que as análises realizadas pelas produções analisadas nesta revisão sugerem que além das dimensões que foram bem trabalhadas, não podem ser desconsideradas também as aprendizagens traduzidas e/ou avaliadas pelo desempenho entre errar e acertar; caso contrário, todas as estratégias metodológicas de avaliação acabam funcionando como norma a ser cumprida para aprovação ou reprovação dos estudantes.

A avaliação tem um horizonte móvel, indefinido, fácil de ser visualizado com o apoio do CmapTools. Permite refletir sobre os diferentes caminhos percorridos, os múltiplos conhecimentos anunciados, com o sentido de ampliação permanente dos conhecimentos existentes. O erro, ou melhor, as "hipóteses construtivas" deixam de representar ausência de conhecimento válido. Antes, pode ser considerado como sondagem ou informação diagnóstica, que mostra visualmente, como o estudante articula os conhecimentos consolidados, os desconhecimentos presentes e os conhecimentos necessários ao desenvolvimento e continuidade do processo de aprendizagem. O erro explicita percursos possíveis para o saber mais, ressaltando a diferença de conhecimentos, lógicas e processos; expõe a diferença e anuncia modos de incorporá-la potencializando a relação ensino/aprendizagem. Indica particularidades que devem ser integradas à dinâmica coletiva e trabalhadas com a marca da originalidade e da criação, aspectos centrais no desenvolvimento da aprendizagem.

A avaliação se considerada apenas como classificatória, concentra-se em tendências mais tradicionais de ensino e de aprendizagem, como a concepção mecanicista, cujos valores focalizam capacidades de memória, armazenamento, reprodução, aprisionando à ideia de avaliação às diferenças que surgem e que acabam não oferecendo informações suficientes para o processo em si. Um processo de avaliação normalmente estabelecido com a exclusão das práticas contraditórias, sem convite ao entendimento das diferenças e/ou outras dimensões, mais se aproxima de uma espécie de enquadramento dos estudantes aos modelos homogêneos pré-estabelecidos e mandatórios. Tal postura distancia processo e produto; esvazia a riqueza que se anuncia com a explicitação da heterogeneidade. A necessidade de apropriação do campo epistemológico educacional sobre o processo de avaliação pode sugerir o fomento de diferentes metodologias, que permitem aos estudantes a oportunidade de desenvolver e ampliar suas capacidades.

Os mapas conceituais efetivam a polifonia, a possibilidade de diálogo, a presença da voz de todos, em diferentes cenários. Os mapas conceituais são, definitivamente, "prática de investigação" permanente que expõe a natureza coletiva da avaliação, o envolvimento de pessoas diferentes e ampliam as possibilidades de compreensão e ação no processo de aprender e de ensinar. As diferenças em um processo de avaliação necessitam ser colocadas em relação dialógica, não em uma escala como identificado nos papers analisados. Explicita o que já foi feito e se sabe, e identifica o que pode ser ainda explorado.

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DISEÑO DE UNA RADIO ESTUDIANTIL CON MAPAS CONCEPTUALES

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Resumen. Los mapas conceptuales han sido considerados como una herramienta valiosa para la construcción, la gestión, la captura, el intercambio y la representación del conocimiento, en diversos campos del saber. En el presente trabajo se muestra una de las aplicaciones que ha sido poco explorada, que es el diseño de medios de comunicación. En la experiencia reportada, los mapas conceptuales permitieron representar y organizar en forma dinámica los distintos elementos que constituyen una radio estudiantil universitaria.

1 Introducción

Los mapas conceptuales aparecieron alrededor de 1972, como parte de un programa de investigación desarrollado en la Universidad de Cornell por el Dr. Joseph D. Novak, quien tenía el propósito de determinar cómo los niños adquieren conocimiento luego de las sesiones de educación formal (Novak y Cañas, 2007). La herramienta se basa en la teoría del aprendizaje significativo, propuesta en 1963 por el psicólogo estadounidense David Ausubel.

Durante más de cuatro décadas, los mapas conceptuales han sido valorados como una herramienta poderosa para la construcción, la gestión, la captura, el intercambio y la representación del conocimiento, en todos los niveles educativos y en diversas disciplinas. En particular, se aprecian como una buena manera de ayudar a un educador a organizar el conocimiento para su labor de enseñanza, así como un buen recurso para que los estudiantes determinen conceptos y principios clave de diversos materiales educativos (Novak, 1998).

Una de las aplicaciones poco exploradas y documentadas de los mapas conceptuales es la sistematización de procesos de comunicación y en particular el diseño de medios de comunicación. En el siguiente trabajo, se explicará cómo se diseñó una radio estudiantil universitaria costarricense con mapas conceptuales, desde sus elementos característicos y sus bases conceptuales, hasta su estructura organizacional.

2 Radio Estudiantil

En el contexto académico de Costa Rica, existe muy poca literatura acerca del concepto de radio estudiantil (Araya-Rivera, 2015), a diferencia de otros países latinoamericanos, Estados Unidos y Europa, donde ha habido mucha más investigación y experiencia sobre este campo. En el caso de Estados Unidos, uno de los autores con mayor desarrollo en este tema es Samuel J. Sauls (2001), quien considera que la radio estudiantil típica no tiene objetivos comerciales y es administrada por un departamento académico. El autor considera además que las funciones de la emisora podrían referirse a proveer un entorno con estándares de la industria en el que los alumnos puedan aprender las diversas facetas del negocio de la radiodifusión, servir al interés público, ofrecer información sobre el centro educativo a la comunidad, brindar información útil a la comunidad, y ofrecer una programación alternativa y poco común en el mercado radiofónico.

Sauls (2001) indica que la radio estudiantil puede adoptar diversos modelos, como por ejemplo uno en que los estudiantes manejan completamente la estación, con un profesor consejero o asesor académico que no ejerce una supervisión directa, o bien un esquema con profesionales que ofrecen tutoría a los alumnos que operan la emisora. La radio estudiantil se conoce más como formato no comercial, dedicado a la transmisión de géneros musicales alternativos y programas elaborados por estudiantes universitarios. En este caso, es llamado *college radio* en Estados Unidos, *student radio* en Inglaterra y *campus radio* en el resto de Europa.

En América Latina se utiliza con mayor frecuencia el concepto de *radio escolar*, para identificar aquella emisora producida por alumnos de enseñanza primaria y secundaria, mientras que el término genérico *radio universitaria* denomina a las estaciones de los centros de educación superior, aunque hay que observar que la mayoría responde a un enfoque académico y tradicional de las universidades, públicas y privadas, y que no necesariamente son de carácter estudiantil, en el sentido norteamericano o europeo.

Para efectos de este trabajo, se utiliza la traducción al castellano del concepto *student radio* (radio estudiantil o radio de estudiantes), y en consecuencia se formula la siguiente definición: La radio estudiantil es un medio de comunicación radiofónica diseñado, gestionado y producido completamente por estudiantes voluntarios de un centro de enseñanza, con contenidos de interés para esta población, que constituye un espacio de experimentación y aprendizaje de la disciplina de la radio y la comunicación, y por lo tanto, en espacio de construcción del conocimiento. Por lo general, cuenta con una asesoría académica permanente, formal o no formal, desempeñada por una o más personas docentes del centro educativo, y cuya labor principal es la de aconsejar y dar continuidad a los procesos de formación, la gestión y la operación diaria del medio.

3 El Proyecto CONTRASTES y RADIO-E

En 1990 un grupo de estudiantes de la carrera de Ciencias de la Comunicación Colectiva de la Universidad de Costa Rica diseñó una radio-revista con orientación estudiantil, con contenidos de interés para la población joven universitaria, tales como información sobre servicios y trámites de la Universidad, reportajes sobre la actualidad nacional y música popular. El programa se llamó CONTRASTES y se transmitió por espacio de nueve semanas en Radio Universidad de Costa Rica. Luego de un replanteamiento, el 24 de abril de 1992 se inauguró el Proyecto CONTRASTES y desde entonces, ha desarrollado procesos de aprendizaje en comunicación estudiantil, que incluyen la producción radiofónica y multimedia, así como un programa de formación en radio estudiantil en centros de enseñanza media pública de Costa Rica, con base en un modelo de voluntariado y desarrollando competencias como el trabajo en equipo y el aprendizaje autorregulado (Araya-Rivera, 2012).

Para el 2010, el Proyecto CONTRASTES inició las pruebas de un nuevo medio, una radio estudiantil digital con transmisión por medio de *streaming* de audio en Internet: RADIO-E (www.contrastes.ucr.ac.cr). La emisora se perfila como una auténtica radio estudiantil, constituida como un espacio de aprendizaje en el que todos los participantes aprenden unos de otros en forma colaborativa (Araya-Rivera, 2013). De esta forma, RADIO-E es programada, producida y gestionada por los propios alumnos, con la asesoría académica de un profesor cuyo papel es el de aconsejar, recomendar y dar continuidad a los procesos.

4 Mapas Conceptuales para el Diseño de Radios Estudiantiles

El diseño de RADIO-E se obtuvo al trabajar en una primera etapa con estudiantes del curso de Radio de la Escuela de Ciencias de la Comunicación Colectiva de la Universidad de Costa Rica, así como con estudiantes de distintas carreras universitarias que participaron en el Proyecto CONTRASTES, entre el 2010 y el 2013. En el caso del curso de Radio, se solicitó el diseño de una radio estudiantil como trabajo final, y con este propósito se construyó un mapa conceptual en forma colectiva, por medio del software IHMC CmapTools (Cañas et al., 2004)

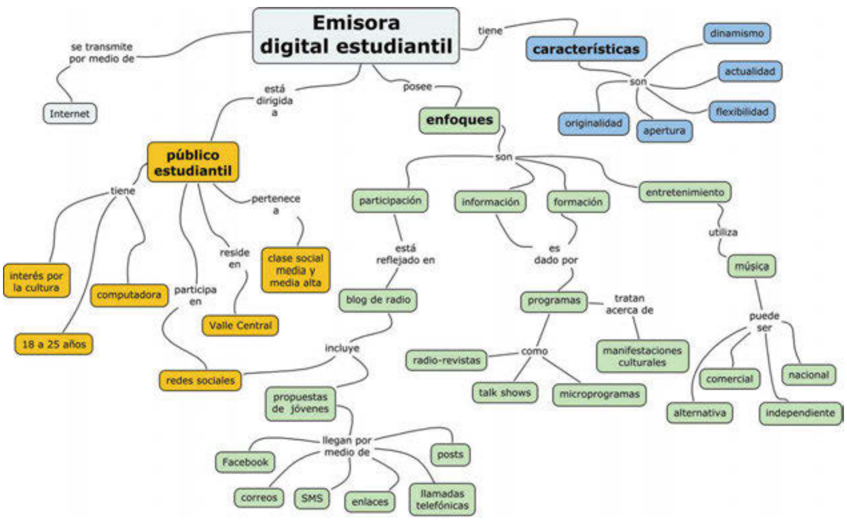

Figura 1. Diseño general de una radio estudiantil. Elaboración: Estudiantes del curso de Radio, Escuela de Ciencias de la Comunicación Colectiva, Universidad de Costa Rica, 2010.

Primero se ofreció a los estudiantes una charla introductoria sobre la herramienta, que consistió en practicar el procedimiento de construcción de mapas conceptuales por medio del estudio de un contenido específico del curso: el género radiofónico del microprograma especializado. Esta experiencia resultó ser pertinente para la comprensión de la temática mencionada, por lo cual fue reportada en un trabajo que se presentó en el IV Congreso Internacional sobre Mapas Conceptuales (Araya-Rivera, 2010). Posteriormente, se procedió a elaborar mapas focalizados en aspectos de la futura radio estudiantil (características, enfoques posibles, público meta y programación). Estos mapas fueron integrados en uno solo, como se aprecia en la Figura 1.

A continuación, el autor sistematizó los principios y objetivos de la emisora, que también son compartidos por el Proyecto CONTRASTES. Este segundo mapa permitió mostrar las bases conceptuales del proyecto, que se refieren al enfoque de procesos en Educación, la mediación pedagógica, la transdisciplinariedad y el pensamiento complejo, utilizando las estrategias didácticas de aprendizaje por proyectos y radio estudiantil (Araya-Rivera, 2012). En la Figura 2 se muestra la vinculación de estos elementos conceptuales.

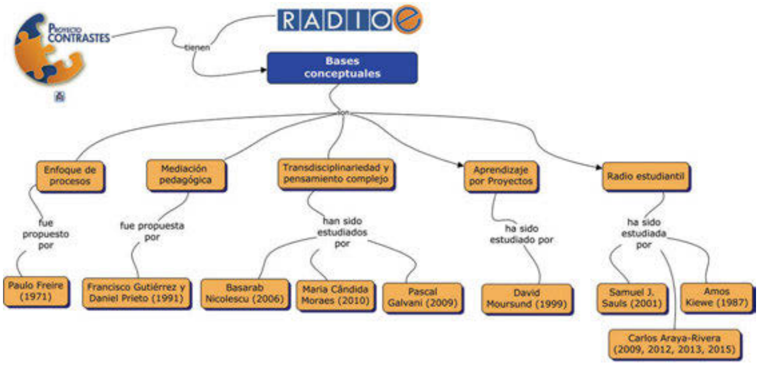

Figura 2. Bases conceptuales de RADIO-E. Elaboración propia, 2016.

Los dos mapas anteriores fueron insumos para la construcción y puesta en marcha de la emisora, que se logró a finales del 2010 con los participantes en el Proyecto CONTRASTES. Como la organización del nuevo medio respondía a la estructura existente del Proyecto, los cuatro equipos de trabajo de este último pasaron a constituir los respectivos departamentos de RADIO-E: Investigación y Formación (que se encarga de los procesos de fundamentación conceptual y de educación radiofónica); Producción (que diseña y elabora los contenidos); Programación (que planifica y organiza los contenidos para su transmisión); y Promoción (que diseña y ejecuta una estrategia de promoción y divulgación para posicionar la emisora estudiantil en sus públicos meta y bienvenido). Los departamentos responden a la realidad de la industria radiofónica, ya explicados por la literatura (Keith, 2009; Hausman, Messere, O'Donnell y Benoit, 2010; Araya-Rivera, 2015). La Figura 3 muestra el mapa elaborado en forma colaborativa por los participantes, el cual representa la estructura organizativa de la emisora estudiantil.

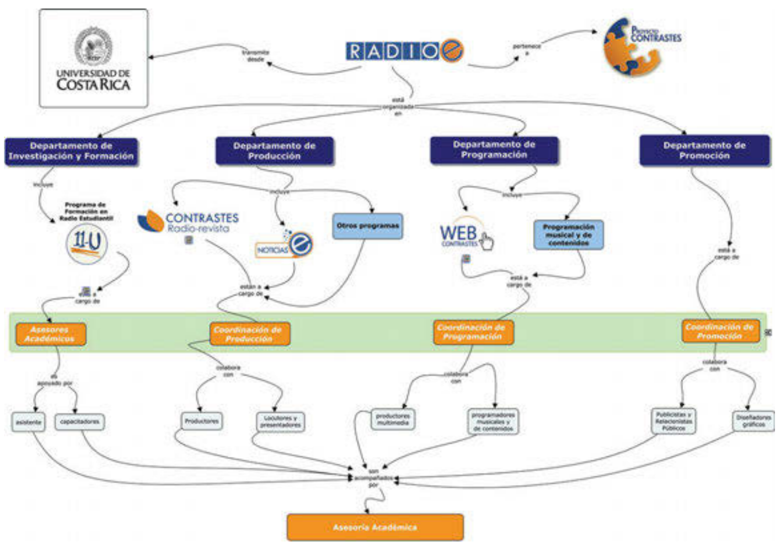

Figura 3. Estructura organizativa de RADIO-E. Elaboración propia, 2016.

A partir del mapa conceptual anterior, se organizó el trabajo de cada departamento de la emisora, para producir programas radiofónicos con temas de interés estudiantil, así como programar y transmitir estos contenidos en horarios apropiados y desarrollar una campaña de promoción del medio de comunicación. Como se evidencia en el mapa, los equipos de trabajo y departamentos colaboran entre sí para alcanzar el objetivo común, que es la puesta al aire de la RADIO-E. Además, el mapa conceptual permite visualizar, de manera clara y sencilla, la participación de cada miembro del equipo y el acompañamiento de la Asesoría Académica, que está a cargo de un docente especializado en comunicación, educación y radio estudiantil.

5 Conclusiones

En el caso presentado, el uso de mapas conceptuales en el diseño de una radio estudiantil universitaria facilitó la comprensión de los elementos que intervienen en la conformación de este medio de comunicación. La flexibilidad de la herramienta, unida a la posibilidad de utilizar el software IHMC CmapTools para la elaboración de los mapas, facilitó la representación gráfica de los aspectos característicos de la emisora estudiantil RADIO-E.

Los mapas conceptuales permitieron además sistematizar el proceso de diseño y elaboración de la radio, así como evidenciar una organización dinámica de las actividades generales del medio estudiantil, en una perspectiva compleja y transdisciplinaria. Con los mapas, es posible apreciar las relaciones entre los distintos actores y equipos de trabajo, al igual que las diversas opciones para el diseño de su programación y la creación de contenidos. Queda pendiente por explorar otros usos de la herramienta, como la formulación de planes de trabajo y la evaluación de las labores cotidianas, lo que permitiría confirmar nuevamente la eficiencia de los mapas conceptuales, no solo en los procesos de enseñanza y aprendizaje, sino también para la sistematización y la gestión de procesos de comunicación.

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EUROPEAN PROJECT OF SCIENTIFIC EDUCATION

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Abstract: In 2016 the final report of Operative National Program ("Competences for the development"), promoted by the General Direction for International Affairs of Italian Ministry of Education, University and Research, has been presented. Such a program has involved about 4000 schools from Calabria, Puglia, Campania and Sicily regions in which several training activities for teachers aimed to improve the teaching quality (especially of mathematics and sciences) took place: in total, 1125 secondary school science teachers have been educated. The management of the program have been entrusted to INDIRE Institute of Florence (National Institute for Information, Innovation and Educational Research), which could rely on European structural funds (PON funds). In order to manage to improve the learning quality of scientific subjects, the educational syllabus has been split in 4 different disciplinary thematic units (reading the environment, earth and universe, transformations, energy and its transformations) and 3 transversal units (history of science, education to sustainable development, learning evaluation). A total of 209 didactic materials have been published, both in paper and multimedia format (containing 25 clips made by the students), mainly addressed to secondary schools (during the last phase of the project some "vertical modules" have been added, in order to propose itineraries going through primary school and the first two years of middle school).

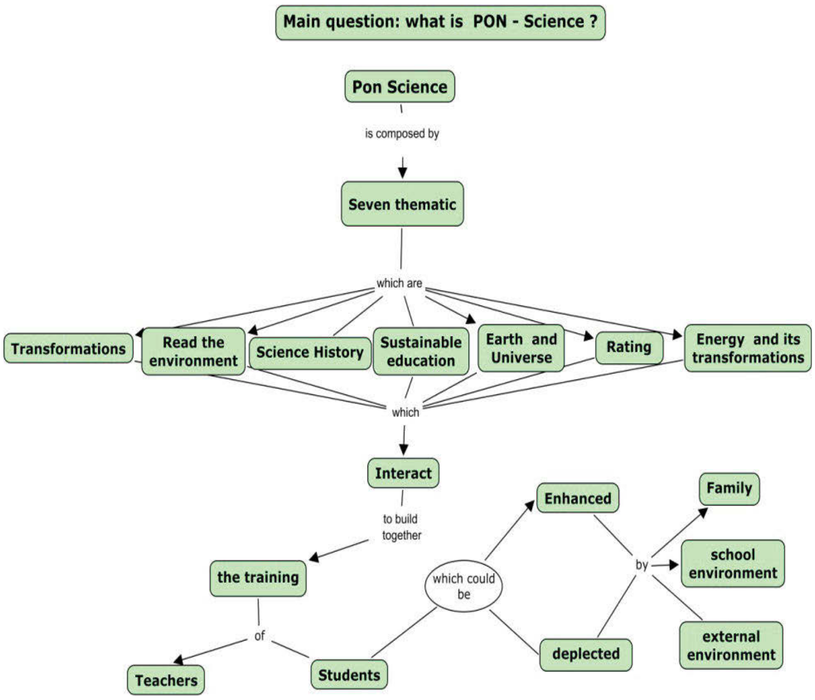


Figure 1. Map of European project educational units.

1. Introduction

The first results coming out from the program highlight encouraging signals, even though the main and the most ambitious goal (didactic improvement and shift to a student-focused teaching) requires a long-term perspective. The project makes the 209 didactic materials and the 25 clips available to the primary and secondary school Italian and European teachers. Workshop and laboratory approach is the strategic choice of the program: laboratories cease to be a physical place confined inside four walls and opens to internal and external problems of the school. The efficiency of this approach is witnessed by the control that scholars have upon the different aspects of learning experience: something from the outside (observations) and something from within (critical thought and meta-cognitive reflection on what observed) melt together and form what we call "Phenomenon" (Wagenschein, 2000). Meta-cognition act is a reflection, based on an experience or a personal thought already fixed inside us, which becomes significant after the concept map construction. If we want the students to build up a real scientific competence, we need to let them the necessary amount of time for continuous and repetitive meta-cognitive reflections, developed through the use of concept maps with CmapTools, realized in collaboration with their classmates both in primary and secondary school. New programs and new investigating activity based approaches to learning require making multiple connections between all that is known and its applications. That is the new idea of class: dividing students in cooperating and interacting groups (with the teacher as well), providing them any kind of problem, for whose solution concept maps represent a valid tool.

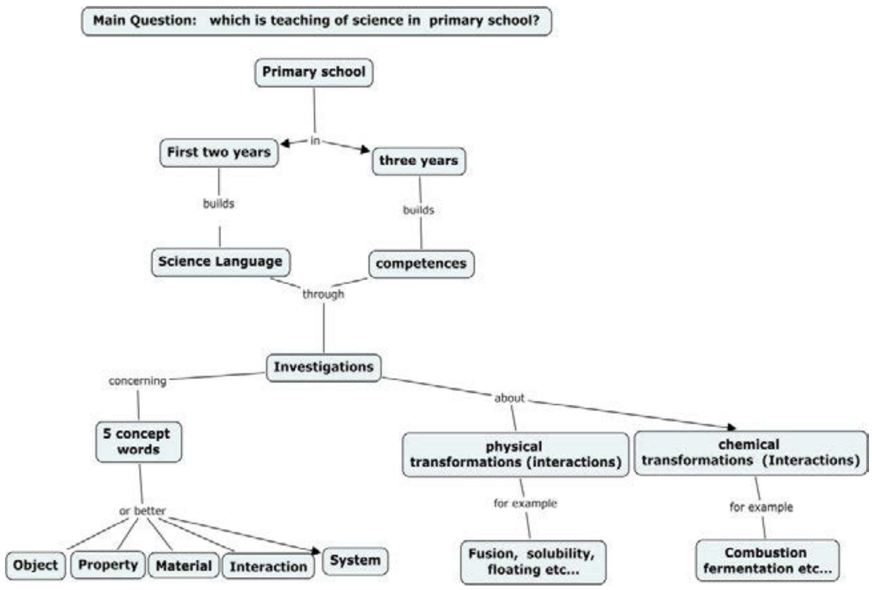


Figure 2. Map of scientific teaching in primary school.

2 Learning Environment Design

Teacher designs and manages science learning in a workshop-like didactic, using cheap and common materials, procedures and contexts in order to put students in a position to "learning by doing". In particular, activities will take place according with the 3 stages of Learning Cycle, theorized by Robert Karplus: exploration, invention and discovery. The European Scientific Educational Program recommends a wide use of investigations and Cmaps in every Italian school grade. Investigations allow ruling abilities to develop ideas and concepts, such as classification ability (Why am I classifying? Which are the properties of the objects I am observing?) or comparing ability (Why do objects look similar? Why do they look different?).

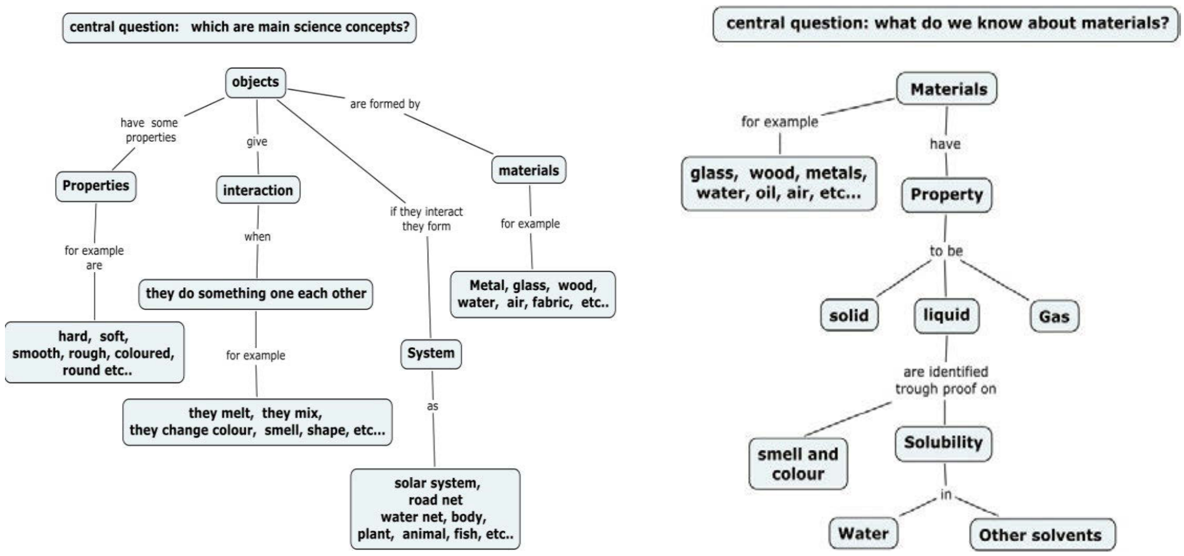


Figure 3-4. Maps regarding the key-concepts of "objects" and "materials".

3 Learning Laboratory

The construction of a basic scientific language always starts from a simple question (or a game), which students are asked to answer after investigating throughout building their own concept maps. This didactic strategy stimulates their curiosity and develops long lasting scientific attitudes. Classroom investigations start with physical objects manipulation, which are thought to help students to realise that the correct scientific language is built thanks to a linking of consecutive investigative processes. Investigating on objects and their properties

In these activities, several examples of investigations will be proposed, lead with different strategies born from the analysis of different objects, in order to determine which is the material carrying the necessary properties for a certain goal.

3.1 Investigating on chalks to discover their properties

Figure 5. Use of chalks and discovery of their properties.

Kids discover that different chalks are made of the same material, but differently coloured, the teacher defines the name of the ideas developed during the activity, putting the meaning into evidence

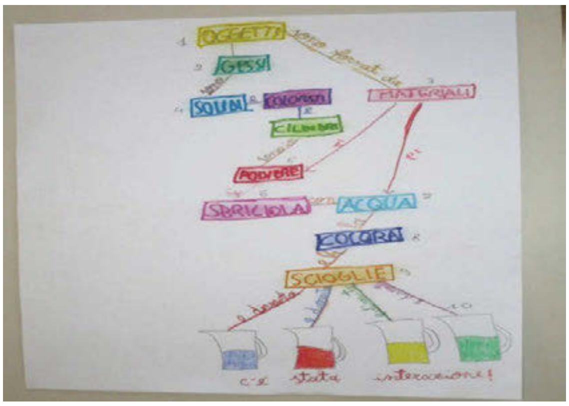
Figure 6

Figure 7

Investigations allow to apply the formerly "invented" concepts and to start exploring new ones. This kind of activities promote the oral, written and iconic language development, ensuring the communication and linguistic ability strengthening

4 Construction of Concept Maps

The teacher's role is essential, since he/she is required to establish the adequate atmosphere, encouraging kids in order to strengthen and address procedures and strategies. Students build their own concept map and connections are described and narrated. Different maps come out, allowing to evaluate the knowledge that learning activity has yield in everyone.



1.Objects

2.Chalks…

3…are made of:

4…are solid, coloured and cylindrical

5…dusty material

6. Interaction

7.Water takes chalks' color

8.Water is a liquid

9. Water melts chalks

Figure 8. Children explaining the map.

Concept maps, built in cooperative groups both in primary and secondary school, play an important social role, since the educative context becomes location of dialogue, comparison, debate and sharing of meanings.

Figure 9

Figure 10

Group maps in primary school are realised in a wide space with movable sheets and labels, in order to facilitate the research of logical and coherent solutions and explanations. Some examples of group maps are reported below.

Figure 11. "Object-Property-Material" map.

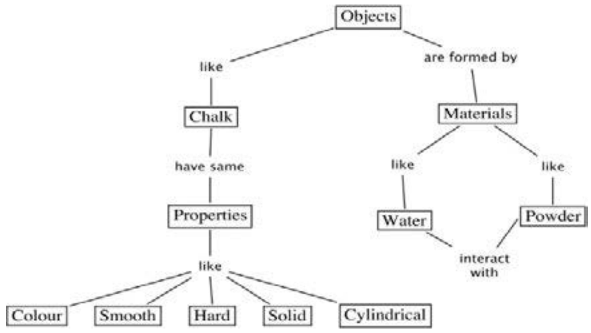


Figure 12. Map realized with software "Cmap".

5 Conclusions

PON project has been founded by European Union and has enrolled about 4000 schools in four different regions (Calabria, Puglia, Campania, Sicilia), promoting formation seminars for teacher aimed at improving the teaching and education of sciences, math and Italian language. In particular, PON Scientific Education Project, which has trained 1125 science secondary school teachers, will be extended to the remaining 16 Italian regions, aiming at improving the quality of teaching in secondary school, considered the most fragile school grade.

209 didactic materials have been published both in printed and multimedia version (containing 25 clips realized by students). The project also recommends the wide use of investigations and concept maps in every school grade, useful to evaluate the improvement of the conceptual structure of both single and group of students. Since the map can be compared to a filter through which students observe the real world, it can also be used as an evaluation tool.

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EXPLORACIÓN METODOLÓGICA PARA EL DISEÑO E IMPLEMENTACIÓN DE UN ITINERARIO FLEXIBLE DE APRENDIZAJE BASADO EN MAPAS CONCEPTUALES

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Resumen. Se presentan de manera detallada la forma en que fue diseñado y desarrollado un itinerario flexible de aprendizaje basado en mapas conceptuales para el desarrollo de competencias de montaje y edición de cursos en Moodle. En la experiencia se describen, con una visión metodológica, tres pasos concretos: el análisis de las necesidades de formación; la conceptualización de los posibles recorridos; y la producción de los recursos a enlazar. Además, se propone una estrategia de implementación y registro para el análisis de los recorridos ideales y reales de los aprendientes.

1 Introducción

El cambio de concepción de una forma lineal y secuencial de abordar los contenidos de un curso, asignatura o temática por múltiples formas de acuerdo a las necesidades del aprendiente, representa un reto en la forma de concebir el acto formativo tanto en el diseño como en la conducción (impartición). Así los *itinerarios flexibles de aprendizaje* basados en mapas conceptuales representan tanto para el diseñador instruccional como para el instructor, docente o formador, un cambio de paradigma con respecto a la forma en que se concibe el aprendizaje del sujeto al que se pretende formar.

La experiencia de desarrollo del itinerario que se presenta, se enmarca el diseño del *Programa de Formación Docente para Modalidades No Convencionales de Aprendizaje* de la Coordinación de Formación Multimodal (e-UAEM) de la Universidad Autónoma del Estado de Morelos, México (UAEM), en el que pretendimos diseñar un recurso que ayudara a los profesores a desarrollar las competencias necesarias para el montaje y edición de cursos en la plataforma Moodle.

Al valorar las necesidades planteadas por este desafío, identificamos al itinerario flexible de aprendizaje como una herramienta que podría atender las necesidades de formación de los actores que presentaban circunstancias diferenciadas.

Es importante destacar que el itinerario se aplica en conjunto con el acceso al espacio de prácticas en Moodle, un "guion formacional" o guión instruccional (que es el documento guía con la descripción detallada del curso a montar) y con la asesoría continua del grupo de asesores.

2 Los Principios Teóricos del itinerario de aprendizaje

Para comenzar el diseño del itinerario que cumpliera las necesidades identificadas en el proceso formativo, fue necesario identificar las características que debería tener nuestro objeto.

En la revisión documental identificamos que Cañas y Novak (2010) proponen una serie de orientaciones para el desarrollo de itinerarios cuando realizan la propuesta de este uso del mapa conceptual, entre las que destacan:

- Un itinerario no es un mapa descriptivo
- Tiene enlazados recursos relevantes en los conceptos
- Proporcionan caminos alternativos de aprendizaje flexible
- Son reusables
- Es una guía para el aprendiente sobre como estudiar el tema

A su vez, Agudelo y Salinas (2013) reflexionan sobre la utilidad de los itinerarios al presentar una serie de rutas, opciones y recursos al aprendiente, que permitirán el desarrollo de una competencia o un saber.

En consecuencia, diseñamos el itinerario con base en el principio de *reusabilidad*, descrita por Cañas y Novak (2010), debido a que el proceso de montaje de cursos puede ser desarrollado por los diferentes actores que intervienen en el proceso de montaje de cursos en línea para e-UAEM:

- Profesores con y sin experiencia como asesores en línea.

- Profesores con experiencia en el montaje de cursos en otras versiones de Moodle o plataformas.
- Estudiantes que realizan prácticas profesionales y servicio social

De Benito, Cañas, Darder, & Salinas, (2010), De Benito, Darder, & Salinas, (2012) y Agudelo, & Salinas, (2013) describen algunas experiencias de trabajo con itinerarios de aprendizaje flexible basados en mapas conceptuales; el presente trabajo pretende reflexionar acerca del proceso de diseño instruccional y construcción para fungir como orientador en este tipo de procesos.

Por la experiencia previa, identificamos al tutorial en video como una herramienta fundamental para la presentación de respondiendo a las conclusiones de la evaluación realizada por los Meij y Meij (2015). Ellos plantean la necesidad de poner especial atención al diseño del contenido en los videos tutoriales para que resulten verdaderamente efectivos y cumplan su función de manera óptima.

A continuación describiremos los tres pasos identificados para el desarrollo del itinerario de aprendizaje flexible.

3 Paso 1. Análisis de las Necesidades Formativas

Parte del proceso de análisis de las necesidades formativas implicaba el reconocimiento del perfil de los sujetos que se requieren formar, en este caso, las características de los profesores, estudiantes y diseñadores formacionales con sus diferentes niveles de aproximación al uso del entorno virtual Moodle (de las que ya hemos hablado).

La segunda parte del análisis de las necesidades formativas implicaba el establecimiento de las competencias que se pretende que los aprendientes desarrollen, para ello se analizaron las competencias del Programa de Formación Docente y se dividieron en competencias específicas, conocimientos, habilidades y destrezas que conforman las diferentes partes del itinerario, dado como resultado la siguiente lista:

- Comprensión de las funciones del rol editor en Moodle.
- Reconocimiento de las equivalencias del guion formacional (instruccional) en Moodle.
- Identificación del formato y configuraciones estándar para e-UAEM.
- Uso de las herramientas básicas de edición en Moodle.
- Ejecución adecuada de la configuración general del curso con base en los formatos estándar.
- Selección de los bloques de herramientas a utilizar en el curso.
- Configuración adecuada de las calificaciones con base en los indicadores de la asignatura.
- Montaje y configuración de recursos.
- Montaje y configuración de actividades de aprendizaje.

Una vez definidos los elementos en los que se divide nuestra competencia general, desarrollamos un mapa, incluyendo, en los elementos que lo requirieran, algunos otros elementos que los conforman a detalle. El mapa desarrollado está disponible en la dirección: https://goo.gl/j0sI8F

Le definición de las diferentes competencias específicas, habilidades, destrezas y conocimientos que conforman la competencia de montaje y edición de cursos en Moodle nos permitió comenzar a visualizar las diferentes formas en las que los aprendientes podrían interactuar con el itinerario desarrollado.

4 Paso 2. Conceptualización de Recorridos

Aun cuando entendemos que el itinerario es una guía y que los recorridos son determinados por las necesidades del usuario, una tarea que nos propusimos al momento de diseñar, fue imaginar los posibles recorridos podrían hacer los usuarios. El proceso de conceptualización de los recorridos permite hacer ajustes en la estructura del mapa-itinerario y al mismo tiempo comenzar a definir el tipo de recursos que se utilizarán para enriquecer los procesos de exploración y desarrollo de las competencias establecidas.

La conceptualización de los recorridos juega un papel importante al momento de desarrollar los recursos por dos razones principales:

La primera es que por los tutoriales desarrollados deberían, desde el punto de vista narrativo, permitir que el usuario iniciara su recorrido en cualquier punto del mapa y por ende no debería existir la referencia directa a contenidos de otros videos tutoriales.

La segunda razón es que al elegir a YouTube como el servicio de alojamiento de video, concebir las posibles rutas para recorrer los materiales, permitió desarrollar listas de reproducción de los tutoriales para incluirlas cuando así se requiriera dentro del mapa conceptual como una opción más de recorrido.

Para desarrollar las diferentes rutas de recorrido utilizamos una tabla (ver figura 2) que representa los posibles orígenes y destinos de los recursos de acuerdo a las habilidades, destrezas o competencias genéricas del mapa, por lo que utilizamos una tabla de orígenes y destinos que nos permitió determinar de mejor manera las rutas ideales por las que podrían recorres los aprendientes.

o/d	1	2	3	4	5	6	7	8	9	a	b	c	d	e	e'	f	f'
1		*	*	*	*	*					*	*	*	*		*	
2	*		*	*	*	*	*				*	*	*	*		*	
3	*	*		*	*	*	*				*	*	*	*		*	
4	*	*	*		*	*	*			*		*	*	*		*	
5	*	*	*			*				*	*		*	*		*	
6		*	*	*	*		*			*	*		*	*		*	
7		*	*	*	*	*				*	*	*		*		*	
8		*	*			*			*	*	*	*		*		*	
9		*				*	*	*		*	*	*		*		*	
10		*				*	*			*	*	*	*			*	
17		*	*			*	*	*	*	*	*	*	*	*			
a																	
b																	
c																	
d																	
e																	
e'		*	*			*	*							*		*	
f																	
f'		*	*			*	*	*	*					*		*	

Figura 2. Tabla de orígenes y destinos de cada uno de los videos a desarrollar utilizada en el diseño de los videos tutoriales. En la columna derecha se describe el origen y en la fila superior los destinos. En ella se puede observar que los elementos 2, 6, e y f son los que más se consultarían después de otros recursos. Cabe destacar que de las letras a la f representan las listas de reproducción temáticas.

5 Paso 3. Desarrollo de los Recursos a Enlazar

Como hemos comentado, los videos tutoriales cumplen una función fundamental en el recurso, pues constituyen el referente a manera de explicación y demostración de los contenidos conceptuales y procedimentales que buscan orientar la acción de los aprendientes.

El recurso requirió la realización de 30 tutoriales para orientar cada uno de los elementos de la competencia escritos en el itinerario de aprendizaje con una narración que permite su navegación no lineal siguiendo todas las posibilidades que plantea el itinerario flexible de aprendizaje basado en mapa conceptual.

Así, se siguieron los procesos comunes de producción, pasando de la redacción de los guiones a la captura de pantalla, grabación de narración, post-producción, publicación en YouTube y vinculación.

Una vez que los tutoriales estuvieron disponibles en línea, se enlazaron en los conceptos correspondientes a cada una de las secciones del itinerario, junto con algunos otros recursos que serían necesarios.

6 Experiencias de Implementación

Por el momento, los resultados estadísticos actuales no nos permiten establecer patrones de comportamiento con respecto a las rutas que eligen comúnmente los profesores. Sin embargo, creemos que, con el aumento de implementaciones, podremos analizar las formas de uso de manera detallada, para los cual hemos implementado algunos pasos en el diseño del curso que nos permitirán tener daos duros:

- Elección de itinerario inicial: Se solicita a los aprendientes determinar la ruta que consideran más adecuada para realizar sus actividades dentro del curso.
- Registro de visita a secciones: Se solicita los aprendientes que registren de manera sistemática las secciones del itinerario visitan, esto permite llevar el control de sus recorridos, generando así una bitácora de trayectoria.

- Comparación de recorridos: Este proceso tiene la intención de detonar en los aprendientes un proceso reflexivo sobre sus procesos de aprendizaje, al tiempo que permite comparar las formas que se pensaba recorrer con el recorrido real.

Contemplamos que estos registros nos servirán más adelante para generar ajustes en el itinerario, así como en los procesos de acompañamiento que realizan los asesores.

7 Conclusiones

El cambio de paradigma de un modelo secuencial a un modelo flexible que representa para quienes diseñan e imparten cursos requiere de un cambio de visión del proceso formativo, pero también de un cambio en el modo en que se conciben, diseñan y presentan los contenidos de los cursos, así como la forma en que se involucra al aprendiente cambiando de ser un espectador al que se le muestra el camino correcto para aproximarse al conocimiento a ser un agente activo.

La explicitación de pasos para el diseño y desarrollo de itinerarios flexibles de aprendizaje permite analizar las propias prácticas de desarrollo e implementación, pero también abre las posibilidades de establecer diálogo en cuanto a las diferencias que existen, desde el punto de vista de la experiencia, en la constitución de este tipo de recursos.

Finalmente, el registro de diferentes formas de construir itinerarios, así como los procesos reflexivos de la forma en que se determinan las necesidades formativas puede ayudar a desarrollar un conjunto de procedimientos que oriente a diseñadores instruccionales en el proceso de diseño de cursos basados en este tipo de estrategias.

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INVESTIGATION OF THE EFFECTIVENESS OF THE USE OF AN ADVANCED CONCEPT MAP IN THE REVISION OF PREVIOUSLY TAUGHT CONTENT

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Abstract. In lessons to revise previously taught science content in junior high school, students were shown an advanced concept map drawn by a subject-matter expert (referred to as an "adult concept map" in this study) and asked to compare it with their own concept maps. Investigation into the effectiveness of revising previous content using an "adult concept map" confirmed, with a 5% risk rate, a significant increase in "more advanced scientific concepts." Results showed that, when revising previously taught content, an "adult concept map" is an effective teaching resource for an improved understanding of igneous rock and minerals.

1 Introduction

Recently in Japan, the concept map (Novak & Gowin, 1984) has been actively used in schools and researchers have progressed in understanding its use. Furthermore, the concept map has gained attention, not only as a method of finding out about the concept that each student holds (that is the level of their understanding of nature and natural phenomena), but also as a tool to encourage collaborative learning and concept construction by students. For example, researchers concluded that using a concept map in lessons promotes concept construction by students. Moreover, there has been research into whether collaborative learning is supported by the joint production of a concept map by a number of students, or the comparison of one's own concept map with those of other students. For example, Taga et al. (2007) investigated the use of a concept map drawn by an older student with a good grasp of the topic and found that a concept map created by a learner with whom the students can identify was an effective strategy. In the lessons in this study, an "adult concept map" was used, rather than an older student's concept map, to verify whether or not it is effective when revising previously taught content.

2 Research Aim

The aim was to investigate the effectiveness of an "adult concept map" in revision lessons, by clarifying its impact on learning previously taught content.

3 Research Method

3.1 Method of Implementation

The students had already been taught about igneous rock and minerals in their science curriculum in the first year of junior high school. To revise this content, a lesson was delivered in March at the end of the second year of junior high school using an "adult concept map." In this lesson, the students were placed in groups of four and instructed to explain their previously drawn individual concept maps to each other and engage in discussion about them, though concept maps they used are not Novakian. Then they compared their own individual concept map with an "adult concept map" which was produced by a high school geology teacher who had taught about igneous rock and minerals for many years (Fig. 1).

3.2 Research Subjects and Content of Lesson

The research subjects were second year students (21 students) at a junior high school in Shiga Prefecture, Japan. In their first year, they had been taught about the types of igneous rock produced from magma as well as the types of rock-forming minerals that make up igneous rock, while observing volcanic ash.

3.3 Implementation Procedure

The implementation procedure is shown in A-D below. The lesson was an hour long (50-minute instruction time).

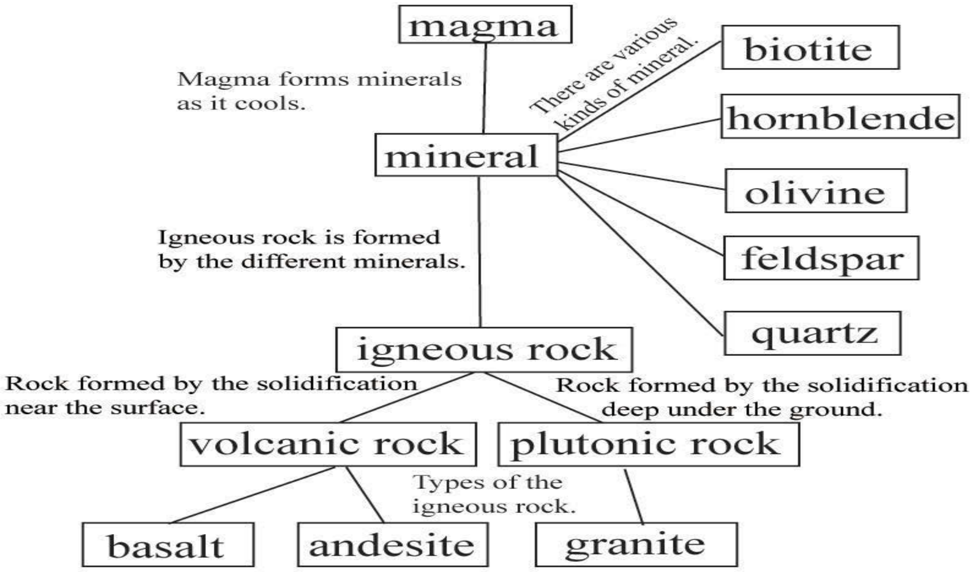

Figure 1. Advanced concept map by an expert adult.

3.3.1 Previous Lesson

In the lesson prior to the lesson in question, the students worked collaboratively in groups of four while sticking text book photos of rocks and minerals onto a big sheet of paper and drawing lines to represent the relationships between the photos. Thereafter, each team gave a three-minute presentation on their design. Students who had not drawn a concept map before were then taught to draw one. Then each student was asked to draw a concept map (the "before" concept map) regarding "igneous rocks and minerals," which is the title of the unit studied in their first year. Nine concept labels were available for use, namely "andesite," "quartz," "hornblende," "granite," "magma," "biotite," "feldspar," "minerals," and "igneous rock." These were chosen from among the vocabulary taught in the first year igneous rock and rock-forming minerals unit.

3.3.2 The Lesson

A. In groups of four, one by one, the pupils each show and explain the concept map they produced in the previous lesson. Each pupil then fills in a worksheet concerning the differences between their own concept map and those created by other students.
B. The teacher gives out the "adult concept map," explaining that it is a concept map drawn by an expert adult and asks each student to compare it to the concept map that they drew themselves. Working alone, each pupil considers points of difference and other noteworthy things and fills in a worksheet.
C. Each pupil draws another concept map (the "after" concept map). The concept labels available for use are the same as before.
D. At the end of the lesson, the pupils write down their views with regard to the lesson.

3.4 Method of Investigation of the "Adult Concept Map"

In order to ascertain whether changes in the pupils' concept were attributable to instruction using an "adult concept map," the "before" and "after" concept maps drawn by the pupils were compared. As an investigation method, in line with Taga et al. (2007), a statistical review was carried out into whether the pupils' concept maps showed a significant increase in understanding the links between words as seen in the "adult concept map."

4 Results of the Implementation

Typical concept map examples are shown (Fig. 2), and there is a numerical demonstration of significant change in the concept visible in the concept maps.

4.1 *Pupils' Concept Maps*

Figure 2 shows a pupil's concept map before the lesson and after the lesson. The concept map drawn after the lesson is more complicated, includes minerals, and shows a deeper understanding regarding the relationship between minerals and igneous rock. The pupil now knows that "magma forms minerals as it cools" and that "igneous rock is formed by the different minerals." Also, the absence of minerals in the "before" concept map implies that the pupil's understanding of minerals was insufficient. However, in the "after" concept map, the pupil mentioned various types of minerals as well as the relationship between igneous rock and magma.

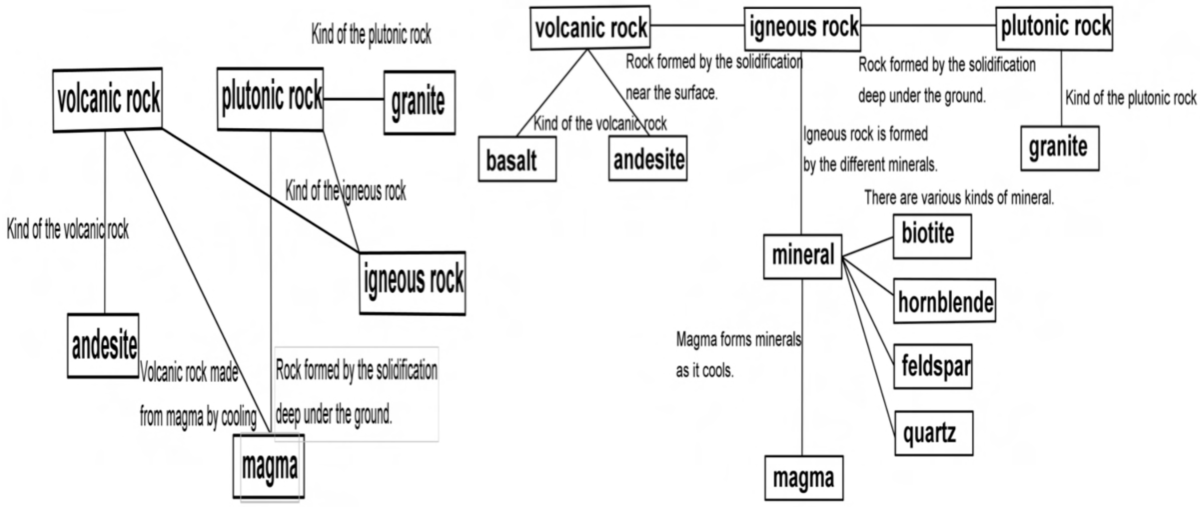

Figure 2. A pupil's concept maps (left produced before the lesson, right after).

4.2 *Analysis Results*

On the "before" and "after" concept maps, the number of "magma – mineral" links (showing that the pupil knows that "magma forms minerals as it cools") and "mineral – rock" links (showing that the pupils knows that "igneous rock is formed by the different minerals") were counted. Whether the number of incidences had changed significantly was calculated using Fisher's exact probability test (two-sided test). The 2x2 cross tables in Table 1 show the numbers depicting the magnitude of the increase and decrease.

N = 21.

"magma – mineral" Magma forms minerals as it cools	Number of links obtained	Number of links not obtained
Concept Map [before]	1	20
Concept Map [after]	19	2

"mineral – rock" Igneous rock is formed by the different minerals	Number of links obtained	Number of links not obtained
Concept Map [before]	2	19
Concept Map [after]	19	2

Table 1: 2x2 cross tables.

The "magma – mineral" link cross table shows a significant increase in understanding that "magma forms minerals as it cools," with a 5% risk rate ($p=0.0000$, $p<.05$). In addition, the "mineral – rock" link cross table shows a significant increase in understanding that "igneous rock is formed by the different minerals," also with a 5% risk rate ($p=0.0000$, $p<.05$).

5 Discussion

5.1 *Review of the Concept Map Analysis Results*

Although they had already been taught about igneous rock and minerals in their first year, few students included the concepts that "magma forms minerals as it cools" (which shows the link between magma and minerals) and that "igneous rock is formed by the different minerals" (which shows the link between minerals and rock) in the concept map they drew prior to the lesson in this study. The existence of these two links leads to the understanding that "minerals crystalize from magma and combine to form igneous rock" and deepens comprehension. In the lesson for this study, each pupil compared their own "before" concept map with the "adult concept map," resulting in a significant increase in the inclusion of each of these links. As a result, students achieved a deeper level of understanding than before the lesson.

5.2 Review of Worksheet Comments

Some of the comments on the worksheets in which pupils compared their map with other people's included: "My concept map was harder to read than other people's; I think that it is OK that some people have written a lot on their concept maps and some people's maps are very easy to read," and "Everyone's was very easy to understand." The pupils were able to look back over their own concept maps objectively by comparing them to concept maps created by other people.

Some of the comments on the worksheets in which students contrasted their map with the "adult concept map." included: "It summarized things in a simple way that is very easy to understand. I thought it would be more difficult with lots of writing, but it was incredibly simple. It was easy to understand." Since the students had already produced their own concept map and compared its features in a group setting, the pupils easily understood the features of the "adult concept map." It is conceivable that, because they had practical experience comparing their concept maps with others, comparing their own concept map with the "adult concept map" led to deeper understanding.

In the final feedback, there were many comments along the lines of: "In this lesson, I was able to recall things that I didn't really understand before and things that I had forgotten and I was able to understand more about volcanoes," and "I think that depicting the relationship between igneous rock and minerals with a link between the words was very powerful. I think that the process of investigating, thinking, and summarizing briefly oneself makes things easy to remember and is effective. In addition, in the final team exchange of views, I was impressed by how other people thought and summarized things. I would like more opportunities of this kind." Students also stated, "By writing a concept map, I got to understand things that I didn't understand before and it was good to learn about things like making concept maps," and "The 'adult concept map' by someone who understood things well was easy to understand and straightforward, and there were many things that I could copy in future."

Pupils who experienced the group activity revised and reconstructed their own understanding of the content by referring to the "adult concept map." In this study, the method of using a concept map in revision lessons was devised, and the aforementioned feedback also made it clear that the "adult concept map" used in this lesson was effective in revision.

6 Summary

In this study, the effectiveness of an "adult concept map" in science revision lessons at junior high school was investigated. The science curriculum content in question related to igneous rock and minerals and involved the revision of previously taught content. In order to deepen understanding of the curriculum content, an "adult concept map" was utilized. As a result, the class using the "adult concept map" significantly deepened their understanding of the definition of igneous rock and minerals and the difference between the two. This made it clear that using an "adult concept map" when middle school students revise previously taught content is effective. Looking ahead, I would like to find out whether the "adult concept map" is also effective with children of other ages.

7 Acknowledgements

The authors wish to thank Mr. Kazuhiko Sawada, a teacher at Karasaki Junior High School, for providing the opportunity to carry out the lesson.

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ITERATIVE CONCEPT MAPPING: THE ROLE OF PEER REVIEW

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Abstract. This case study adds to the iterative concept mapping and peer evaluation of concept maps literature base. Using a peer evaluation checklist and guidelines, graduate students' peer-reviewed concept maps developed over the course of a semester class. Each iteration of the concept maps continued to answer the same class developed question from the beginning of the semester. A quantitative review of the maps indicated that most maps changed between 25-30% from the initial concept map to the second iteration. Students (N=6) noted that the peer review encouraged them to develop the maps to continually answer the overarching question for the course. Each iteration of the students' maps built on the previous iterations and demonstrated the growth of knowledge and depth of understanding as evidenced by the relational links.

1 Introduction

Over the course of a college semester students invest time and energy into studying, reading, and creating artifacts that represent understanding and obtaining knowledge. One way to document and provide tangible results of this knowledge is by having students create a concept map through an iterative process. It is assumed as a student progresses through the semester that their concept maps will be more refined, evidence greater depth of knowledge, and will have meaningful cross connections.

2 Concept Maps Defined

Researchers identified concept mapping as a learning strategy that engages the learner in a meaningful learning experience (Novak, 1998; Novak & Cañas, 2006a, 2006b; Novak & Gowin, 1984). A concept map is a graphical representation of knowledge designed to explain an idea or concept. Novak (1998) described concept maps as a "knowledge representation tool" (p. 3). Concept maps are categorically a part of the graphic organizer family.

The active process of developing a concept map moves students from being passive to active learners (Clayton, 2006). The learner sifts through content taught to extract the most important concepts and then determines the relationship of the information to other known content and graphically presents the information in a logical and hierarchal manner. Novak and Gowin claimed that concept maps were "developed specifically to tap into a learner's cognitive structure and to externalize for both the learner and the teacher to see, what the learner already knows" (p. 40). It is like taking an Instagram of one's thoughts about the focus question the map is answering (Campbell, 2016).

3 Iterative Concept Maps

Iterative concept mapping also called serial concept mapping (All & Huckey, 2007) is a process whereby a person authors, modifies, and contributes to building a concept map about the same content over a period of time. Usually, iterations are completed after new instruction or experiences. In this study, the participants used one map over the entire semester and exported a .pdf or .jpg of the map at each iteration. The final map was the summative results.

4 The Study

Within this semester long study, graduate education students created four iterations of a map answering a question that was developed by the class at the beginning of the semester. The purpose of the research study included answering these research questions.

4.1 Research Questions

1. How does iterative concept mapping over the course of the semester indicate the graduate students' knowledge and understanding?

2. How does the peer review of maps effect the quality and structure of a concept map?

3. Do concept maps answering the same question reflect evidence of the individuals' experiences?

4.2 Methods

4.2.1 Participants

The participant for this case study were 6 graduate students from a large southeastern university in the United States of America. These students were either in educational technology certificate program or in a Masters' degree program in Education. Each participant had completed at least 9 graduate hours in education or already had earned a Master's degree. Five of the participants were currently teaching and the other was in an education related field. All participants were female. All participants completed all aspects of the study.

4.2.2 Procedure

At the beginning of the semester, participants were instructed on the principles of *Novakian Concept Mapping*. These lessons include the history of concept mapping, the purpose for concept mapping, elements of a concept map, and how to build a concept map. Participant practiced their own concept mapping efficacy by deconstructing existing maps to identify the elements of a map. Their map building schools were fostered through whole class, small group, and individual map building. Participants were then taught to evaluate sample maps as peer reviewing others' maps were a part of the iterative concept map assignment.

The class then developed a comprehensive question they would be answering throughout the course of the semester. The question was built based on their knowledge of the course content after having examined the syllabus and course description, reviewing the course projects, and indicating what they wanted to know as a result of completing the class. A predetermined schedule with peer review dates was assigned. The first, second, and fourth iterations required peer review. The third iteration's peer review was optional. The first, second, and third iteration required self-evaluation, the fourth iteration self-evaluation was optional. Finally, participants were required to complete a reflection about their map and about the process of building their maps. The instructor reviewed the first and final iterations.

Peer review was completed using a form that facilitated structure and form concerns as well as content. Peer reviews were required and shared with both students and the instructor. After the 4^{th} iteration students combine all elements into a final submission that included each iteration of the maps, the peer reviews, the self-evaluations, and a final reflection of the entire project. Finally, the students met and for a student-led discussion about the process of creating maps and how they evidenced their learning.

At the completion of the semester, a coder analyzed the structural and content changes from the first map to the final iteration to determine percentage of change for both of these elements. Preliminary results are being shared.

4.2.3 Instruments

The Self-Evaluation Form: The self-evaluation form is completed by the student prior to sharing the map for peer review. The student self-evaluates the map and answers 2 open ended questions:

1. Can you identify any content that may need to be clarified or expanded on for better understanding?

2. Is this map representative of what you understand about the focus question?

The Novakian Concept Mapping Peer-Assessment: Peer review other peers' maps and identifies structural elements including links, structure (hierarchal), and relationships. The content of the map should answer the focus question and through this instruments peers can indicate to what level this is evident to them in their peer's map. Open-end questions included: Did you learn anything new from reading someone else's map?; Can you identify any content that may need to be clarified or expanded on for better understanding?

4.3 Results

An evaluation of the peer, self, and final reflections and the maps themselves were considered to obtain the results for each question.

1. *How does iterative concept mapping over the course of the semester indicate the graduate students' knowledge and understanding as reflected in the students' maps and final reflection?*

The student-developed focus question for the semester: How does educational technology impact teaching and learning practices. The class content was about technology resources in education.

An analysis of students' final maps indicates there were many changes. Only one map was not initially structured hierarchically; however, it was changed from a web format during the second generation. Another structural change was the highest concept. In the first iteration over half of the students used the question as the highest ordered concept. All but one participant changed that by the second iteration and that participant changed it by the third iteration.

Regarding evidence of learned content, each iteration was planned to be completed after a module was completed. It was anticipated that additional content would be added based on new knowledge acquired from the readings, instruction, and other assignments. A review of the maps indicated that most maps changed between 25-30% from the initial map to the second iteration. Propositions (concept, link, and concept) changed to be more specific and new propositions were added.

In their final reflections, students noted several differences evident in their final maps that did not appear in their first or other iterations. These changes included change in structure, more complex thought, sophisticated interrelationships, and depth of content.

2. *How does the peer review of maps effect the quality and structure of a concept map?*

The first and second self-evaluation and final reflections provided information directly from the participants related to the participant's perception of peer influence. All participants indicated on the first iteration that their peer's comments made them reassess and in most cases make changes to their maps. Comments from the second iteration included that participants took greater care in making sure their map could be read by someone else for understanding. Others said that they moved the question from the highest concept in the map to not be a part of the concept map but to appear on the map as a reminder. Students mentioned that they spoke with their peer evaluator to clarify misunderstandings an in the process it helped them articulate their own understandings.

3. *Do concept maps answering the same question reflect evidence of the individuals' experiences?*

Not only did the researchers consider the maps to provide the data to answer this question but the participants themselves organically realized that indeed their individual backgrounds and experiences were accounted for in every iteration of their concept map. Those who were teaching in the classroom referenced the grade or populations they taught. The other working in education mentioned their own educational background. One person wanted to include the name of an application but could not remember the name. She spent hours finding more resources and learning more content that was not assigned. Her personal research beyond the scope of class requirements were evident in the map.

5 Discussion

Participants were engaged in meaningful learning during the course of the semester as evidenced by their concept maps. The participants remarked they were engaged in critical thinking as they worked hard to synthesize what they were learning and in analysis as they considered how to make connections on their map. Concept maps provided the participants an overview of what they learned throughout the semester. One student remarked it required more brain power to complete a concept map of a semester work of material than it did to take a final exam.

Other results from the study may inform how peer evaluation is incorporated into subsequent studies. For instance, a plan was put in place in case someone did not complete their map or peer review by the deadline. Scaffolding how to peer review concept maps may be necessary. When one participant did not thoroughly complete their peer review, they were partnered with another person to review another map. After the initial iteration peer review, debriefing about the peer review process can aid in supporting subsequent peer reviews.

In this case study, the student-created concept maps evidenced students' comprehensive understanding of a semester's worth of teaching and learning. Individual's concept maps were modified and refined based on self and peer analyses. Finally, in each of the final concept maps created individuals personalized their maps based on their own background and experiences.

The nature of a case study limits the generalizability of results from this study to other contexts. However, it does provide evidence that could be considered for designing a future research study. Concept maps have been studied and researched since their inception (Novak, 1967). Educators could consider incorporating concept maps as a formative and summative evidence of conceptual knowledge. This study adds to the literature base on iterative concept mapping and peer evaluation. In this case, including a peer review process after each iteration improved the development and quality of the participant's concept map. Future research is needed regarding peer review and iterative concept mapping.

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LOS MC PARA REPRESENTAR LOS COMPONENTES CONCEPTUALES Y OPERATIVOS QUE CARACTERIZAN UNA BUENA PRÁCTICA DOCENTE EN EDUCACIÓN INFANTIL

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Resumen. Este trabajo es fruto de una investigación en la que participan universidades europeas y latinoamericanas con el objetivo de identificar, analizar, sistematizar, representar y hacer visibles 100 buenas prácticas en los diversos componentes y dimensiones que caracterizan a la Educación Infantil, para establecer un marco de criterios, características y condiciones plural y flexible, fundamentado en la normativa y directrices oficiales aplicables, en los resultados de la investigación y en la literatura internacional, y ponerlo al servicio de profesionales e investigadores capaces de generar dinámicas de colaboración e intercambio de experiencias. Mediante las narraciones de los docentes y las observaciones, se vinculan las creencias asumidas con las prácticas que desempeñan y se representan los criterios y las características de una buena praxis con el empleo de los MC.

1 Introducción

La educación durante la primera infancia es fundamental para el desarrollo posterior (Palacios & Castañeda, 2011) de ahí que la prioridad estratégica de las instituciones es promover la investigación educativa con el objeto de analizar, sistematizar y compartir buenas prácticas de atención a la infancia, haciéndolas visibles a la comunidad educativa mundial para que sirvan de referencia en el desarrollo de las políticas educativas como las propuestas por el Bureau des Institutions Démocratiques et des Droits de l'Homme (BIDDH) (Biddh, 2011; Campos, 2013).

Las buenas prácticas se refieren a aquellas modalidades diversas de responder con eficacia y satisfacción a las diferentes demandas del contexto (Braslavsky, Abdoulaye & Patiño, 2003). La identificación y visibilización de buenas prácticas, se realiza desde una perspectiva inductiva y situada, ya que no existe un modelo de buena práctica transferible a cualquier situación y contexto. El potencial de una buena práctica se sitúa en el buen hacer en la práctica (Zabalza, 2012) y está condicionada y regida por las creencias de quienes la realizan (Zabalza, 2009) por lo que para analizarla y descubrir los criterios que la identifican es imprescindible comprender el contexto y las intenciones (Baudouin y Friedrich, 2000) que además se pueden recuperar mediante técnicas de ingeniería del conocimiento (Cooke, 1994), como son los mapas conceptuales (González, 2008).

Esta investigación de orientación básica y aplicada, se sitúa en la línea estratégica de identificación, análisis, representación y visibilización de buenas prácticas (Howes, 2010) teniendo en cuenta las dimensiones que satisfacen los criterios de buenas prácticas en educación inicial (Lewin Benham, 2011). Se plantea desde una perspectiva internacional multicultural y multidisciplinar para identificar modelos que respondan a las características propias del contexto cultural en los diferentes modos de atención a la infancia y en las diversas áreas curriculares. Tiene en cuenta los cinco ámbitos descritos por el (BIDDH) (Biddh, 2011) para analizar buenas prácticas en la Educación Infantil: la normativa aplicable, la organización de las instituciones y los dispositivos al servicio de esta etapa, el diseño curricular y los ambientes de aprendizaje, y la inserción en el contexto y el trabajo con las familias. Se sustenta en tres elementos fundamentales para el estudio de buenas prácticas: la visión personal de los agentes, las prácticas en sí mismas y la relación entre ambas. Emplea metodologías que facilitan la visibilización de las creencias asumidas epistemológicas, didácticas y actitudinales por su importancia en la construcción de la identidad profesional (Barnett & Di Napoli, 2007) y en las prácticas del profesorado (Bain, 2006), como son las historias de vida (Prieto, 2008) y la Teoría del posicionamiento (Davies & Harré, 1990). La investigación se completa con el diseño de un dispositivo informático que permite mediante un mapa conceptual, (Novak, 1998) visualizar la gramática global de las ideas que subyacen a las prácticas estudiadas y referirlas a prácticas concretas.

2 Desarrollo de la Experiencia

Nos ceñimos a una práctica concreta titulada *Familia y Escuela: entramado de relaciones*, realizada en el colegio público San Francisco de Pamplona, ubicado en el casco histórico de la ciudad. Cuenta con 9 unidades de 2º Ciclo de Educación Infantil, de procedencia inmigrante y de etnia gitana mayoritariamente. La experiencia se realiza con niños de 3, 4 y 5 años, dependiendo del curso escolar que tutoriza la docente. Se construye la muestra con criterios de innovación en relación a la atención asistencial y educativa, mejora, fundamentación científica, evaluación y de satisfacción de los agentes implicados. Se diseña una entrevista que permite reconstruir el desarrollo profesional del profesorado, evidenciar los cambios que se han producido en cuanto a sus ideas en torno a la docencia y la Educación Infantil, y analizar la buena práctica a tenor de las 4 categorías en las que se organiza el contenido: descripciones y valoraciones sobre la práctica, concepciones sobre creencias y teorías, y teorías prácticas sobre cómo deberían hacerse las cosas. La unidad de estudio es la buena práctica por lo que se realiza un primer análisis intra-práctica, un segundo intra-grupo y un tercero inter-prácticas, con el objetivo de identificar y representar la estructura de características, principios y condiciones que caracteriza una buena práctica educativa, así como de evidenciar la relación entre las creencias implícitas y las prácticas analizadas, empleando una metodología de orientación fundamentalmente cualitativa.

El procedimiento se inicia con la revisión documental de normativas y estudios referidos a las condiciones y estándares que debe reunir una Educación Infantil de calidad. Para conocer iniciativas susceptibles de ser seleccionadas, se parte de consultas a diferentes informantes conocedores del ámbito de la Educación Infantil en la comunidad y se seleccionan los ejemplos de buenas prácticas a través de criterios establecidos previamente por el equipo, teniendo en cuenta que no existe un modelo de buena práctica transferible a cualquier situación y contexto. Se establece no obstante como criterios teóricos básicos necesarios para una buena práctica en Educación Infantil la teoría pedagógica de Loris Malaguzzi (2001) y la experiencia de Reggio Emilia (Benham, 2011), el aprendizaje significativo (Ausubel, 1963) y su praxis (Novak, 1998) y los paradigmas de calidad (Azcona & Hoyuelos, 2011; González & Abascal, 2007) como respuesta a las exigencias educativas que plantea el Espacio Europeo de la Educación.

3 Resultados y Discusión

En cuanto a datos vitales, esta maestra está muy implicada en procesos de reivindicación social y política desde su adolescencia "*Mi adolescencia coincidió con los años de la llegada de la democracia. Fueron unos años maravillosos de profundos cambios personales y sociales que viví con toda intensidad siendo alumna de un Instituto público de la ciudad. El cine y la participación ciudadana ha sido a lo que he dedicado una gran parte de mi tiempo libre"* Opta de forma consciente por la escuela pública, donde además realiza tareas como representante sindical, "*Trabajar de maestra en la escuela no fue una elección pensada y decidida con antelación, hacerlo en la escuela pública si fue una elección reflexionada y elegida"* y se forma en coeducación, ecología, inmigración, lenguas minoritarias, cultura autóctona y territorio "*He tenido una formación muy vinculada a los procesos sociales y de reivindicación política*", ámbitos que aunque aparentemente no tienen relación directa con la práctica docente *"sin embargo inciden fuertemente en ella".* El momento formativo de mayor impacto en su proyecto vital es cuando conoce el trabajo realizado en las escuelas infantiles municipales de Reggio Emilia en Italia, formación que transforma su manera de entender la educación y la vida "*después de mi estancia y formación muchas cosas han cambiado en mi manera de trabajar en la escuela y también de entender la educación y la vida. He podido ir haciendo cambios en mi práctica docente*".

Entiende que una buena práctica implica reflexión continua "*Es aquella a la que pongo en cuestión cada día"* y parte de la práctica diaria. En concreto ésta que presentamos, se implementa con el objetivo de adaptar el proyecto educativo de la etapa de Educación Infantil a la realidad social del centro "*Se acerca a las familias a la realidad de la cultura educativa de la escuela y se establece un dialogo con su forma de entender la educación.* Considera que para realizar una buena práctica es fundamental que la escuela sea construida por toda la comunidad educativa donde las familias ocupan un lugar importante "*Se trata de entender su modelo cultural para llegar a consensos en la educación… y contribuye a crear un clima de participación y tolerancia, con el objeto de educar en valores compartidos entre las diversas culturas que acuden al centro…colaboran activamente las familias, así como colectivos de atención educativa complementaria, para entre todos tomar decisiones que faciliten la adaptación de los niños al ámbito educativo".* Una buena praxis provoca cambios en todos los agentes implicados en la educación, tiene que ser reconocida como tal por parte de las familias y de otros profesionales, y además implica satisfacción "*está dirigida a profundizar hasta el infinito en las posibilidades y oportunidades de relaciones que se pueden llegar a establecer entre las familias de inmigrantes y la escuela, con el objeto de que se sientan parte del centro, para enriquecer la educación"* Se inicia la intervención tras invitar a los padres a acudir al aula un día concreto, con el objeto de que vivan in situ la realidad de la clase. Mientras un profesor desarrolla su labor con los niños, el otro (se trabaja por parejas educativas) explica y atiende las dudas que van surgiendo "*Es muy importante que evidencien cómo se atienden los conflictos y las interacciones, tanto entre los niños como con el docente*". Estas sesiones sirven a su vez para compartir sus creencias sobre el proceso educativo, y para conocer sus necesidades "*Un primer paso para establecer entramados de relación, implica el que las familias se sientan escuchadas y bien atendidas…Se trata de que el centro "comprenda su cultura, su manera de entender la escuela y la forma en la que educan a sus hijos, para llegar a consensos eficaces y eficientes en la forma de educar…Para lograrlo, se invita a las familias a permanecer en el aula todo el tiempo que necesiten…La* *llevo realizando desde hace 6 años…* con espacios de reflexión, donde cada niño y niña es diferente y singular *"El tiempo dedicado varía y es diferente para cada familia y su hijo o hija*"

La práctica debe ir encaminada a educar más que a formar, poniendo en valor el gran potencial de las criaturas para construir su propio aprendizaje mediante la experimentación y el juego mediante proyectos abiertos que faciliten un mayor conocimiento de la cultura de la infancia y proporcionen experiencias ricas, de interés para los niños y niñas. "*Debe favorecer la curiosidad, la creatividad y la motivación por aprender…lo hago con el objetivo de ver al alumnado que siente un mayor amor por el aprendizaje, que despierta su curiosidad, que le provoca ser más creativo y que le abre otras perspectivas*" y tratar al alumnado como un todo "*Atiende al desarrollo afectivo y social del alumnado".* El papel del maestro y la maestra debe ser el de observar, acompañar, aprender con los niños, ahondar en sus potencialidades, documentar los procesos de vida, respetando la cultura y los tiempos de la infancia y viviendo la práctica desde la complicidad y el asombro. Es fundamental la reflexión constante en reuniones pedagógicas y para ello "*las visitas se documentan gráficamente con la documentación fotográfica que vamos tomando el equipo docente realizamos PowerPoint que mostramos en las reuniones con las familias y aprovechando dichas reuniones les invitamos a explicar públicamente cómo fue su experiencia.* Los resultados demuestran un alto grado de eficacia *"se constata que cada año a raíz de las mejoras introducidas por los procesos de revisión que los resultados son mejores*"

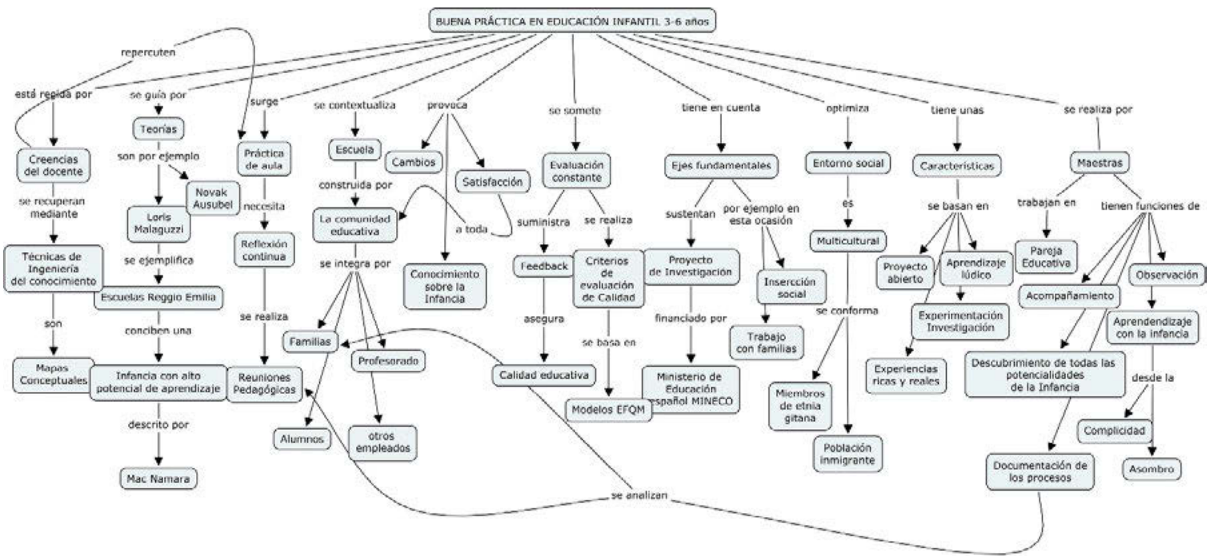

Figura 1. Para la construcción del MC, se han tenido en cuenta todos los elementos constitutivos de la buena praxis, organizados en conceptos relacionados por enlaces que muestran sus interconexiones.

4 Conclusiones

La metodología empleada (Prieto, 2008; Davis & Harré, 1990) y el empleo del Mapa Conceptual, permiten identificar las características básicas (contextuales, conceptuales, operativas, actitudinales) de cada experiencia y visibilizar los elementos clave y las relaciones entre ellos, de tal forma que se identifica dinámicamente el esquema conceptual de los agentes y se relaciona con las secuencias de acción que se han desarrollado (Barnett & Di Napoli, 2007 Bain, 2006; Baudouin y Friedrich, 2000). En suma, se sistematizan las cualidades, los criterios que la estructuran y la convierten en una buena práctica, y se esquematizan y construyen los ejes interactivos de cada experiencia, relacionando fundamentación y puesta en práctica, ideas y acciones (Trigwell, Prosser & Waterhouse, 1999; Zabalza, 2009).

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MAP/UML OUT: CONVERGENT CONCEPTUAL CONSTRUCTS

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Abstract. This research initiative suggests continuing the concept map experiment that was carried out in Hope International School in Cambodian among Year 8 and Year 9 students of the extended math. In the previous experiment students were taught the concept map technique and the first implementation was to describe the whole IGCSE math syllabus. The intended study should be executed by transforming the students' syllabus map on the paper as an electronic version, and then use it as a knowledge building tool, when new topics are introduced and old revised. The map visualizes the existing conceptual structure and whenever new information is brought in, it will be placed and situated in the map and the linkage to the prior knowledge will be explicated. For revising, the map will also contain links to revision questionnaires and exercises of the past GCSE/IGCSE papers. The system authenticates users and responses will be stored for assessment and data analysis purposes, hence, the system functions simultaneously as a research instrument. However, it would be good to complement the information with the traditional pre- and post-tests. Instead of measuring the skills in only one particular area, these tests should be targeted in measuring the "big picture" of math and preferably compared with results of a control class regarding the traditional subject domains but additionally getting a better overview of math in general. However, the concept mapping as a metacognitive tool belongs to the bigger entity of 'learning to learn' cross-curricular learning goals, thus we propose that while launching mapping in math it will be simultaneously supported with parallel activities in the subjects of English (mother tongue) and ICT.

1 Introduction

Alas, school mathematics is oftentimes understood plainly as problem solving. Mastering math concepts is not in the center, which might lead to weak concept possessing that in continuation may cause problems especially with word problems. Embracing essential concepts paves the way for the next phase of linking concepts together and to prior knowledge. Deep learning is claimed to happen when data is associated robustly to the existing conceptual structure, and concept maps may be used as a tool that enables connecting concepts to each other explicitly. The visualized connection phase also exposes possible misunderstandings. In math a more detailed development of conceptual understanding and getting a bigger picture of math is less frequently set as one the main learning goal not to speak of examining it - a deficiency, which is addressed by this research initiative.

Ausubel (1962) stresses conscious elaboration as the main means of meaningful learning requires conscious effort to link new knowledge to existing cognitive structure that may be illustrated as a concept map. In teaching and learning this calls teachers for explicating the underlying principles and connecting it to prior knowledge, whereas learners should become more aware of concepts, their relations. In general, modelling and abstraction skills are beneficial for 'learning to learn' purposes. Being aware of one's best strategies for learning is a part of meta-cognitive skills. Ultimately, the learner is meta-cognitively mastering the process of making necessary associations in order to deepen the learning. The high road transfer means that the abstract knowledge is transferrable to other domains as well (Perkins & Salomon, 1988), and explicit abstraction and linking to other domains foster the transfer.

Concept maps as visual representations of the schema enable grasping a bigger picture of the content (Novak & Cañas, 2008). In this research initiative, we propose that the map should be designed to be digested at a glance to give the whole overview with the option of zooming into details, if desired. In addition, individual nodes should be visually appealing and contain visual hints as images and even video tutorials. The map should be implemented by using state-of-art tools such as Prezi and Google Docs. The students should be allowed to add content, for example, videos demonstrating solutions to past paper exercises.

We note that the concept map of the math syllabus is only one application of the bigger target of learning-to-learn skills. As other complementing applications, we suggest that the concept mapping will be used both in English (mother tongue) and ICT lessons. In English, when writing a data essay, the bigger text mass should be first illustrated as a map, after which the initial text will be taken away and the map will be used as a parsing tool and organizer or the abstract to be written. Conceptualization is an essential skill also in ICT modelling, e.g. to communicate the overall component and class structure of a system when a new artifact is being implemented. This initiative notes the value of conceptualization not only for learning to learn, but paving the way for UML diagrams used in describing the architecture of ICT systems.

2 Learning Artefact for internalizing Math Concepts and Big Picture

Figure 1. IGCSE math syllabus map on the paper

Year 8 and Year 9 of Hope International School cooperated in preparing the poster. Together with students we painted the background and produced the syllabus area transparencies. We were capable of finalizing the map a day before the semester end, see Figure 1.

The next phase was to transfer the syllabus map in Prezi, see Figure 2. In addition, the underlying system should be implemented to support all the needed functionality, i.e. authentication, auto-assessment, saving user's actions and responses for further manipulation and a portal for students to add their own content, e.g. solutions videos or new questionnaires.

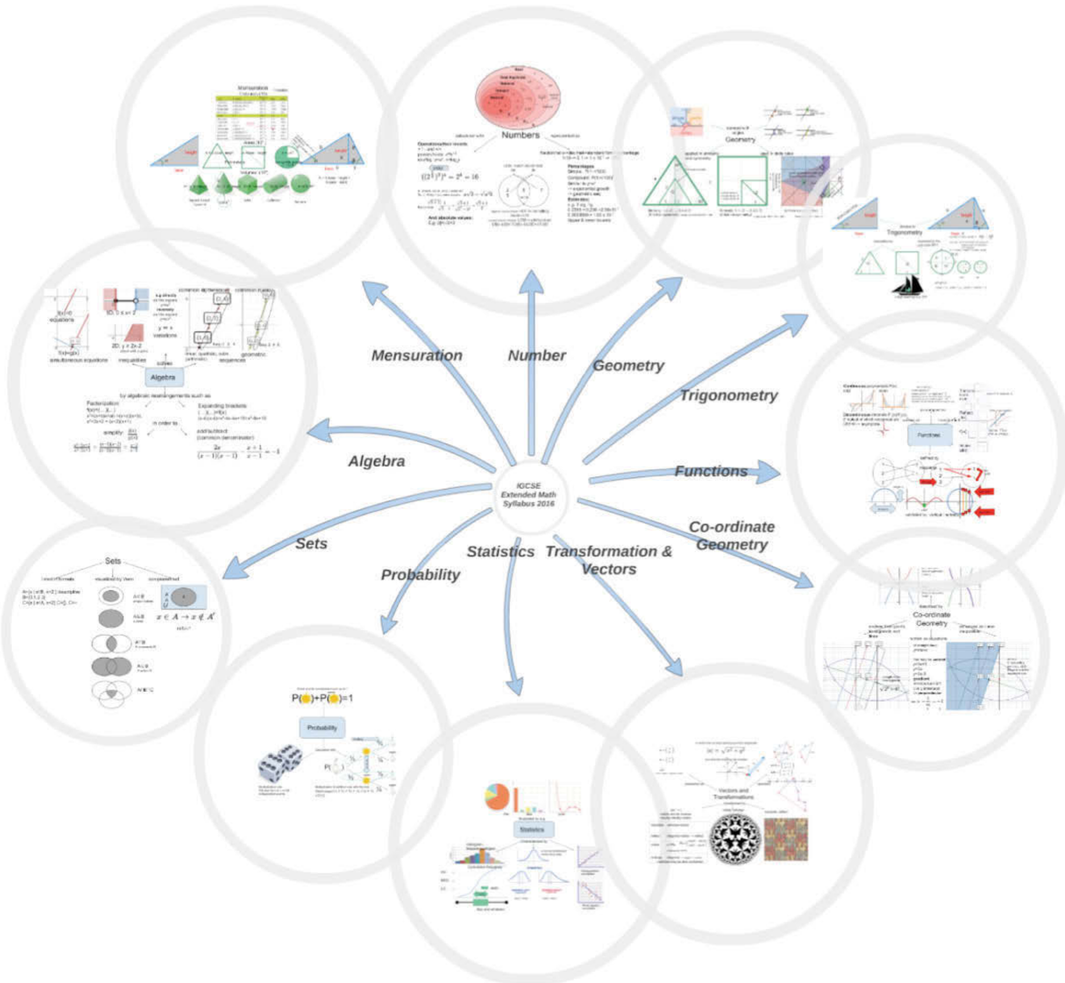

Figure 2. IGCSE math syllabus in Prezi and as the graphical user interface (GUI) of the intended learning artefact

The map should contain links to both questionnaires, past paper exercises and their solutions. Even if the first page is static, the next page should allow both a teacher and students to manage content, e.g. to add questionnaires and videos. The teacher should get results as histograms illustrating clearly the performance of the whole class, also zooming to one students at a time should be provided. The student should be able to see his own results and manage his uploaded content.

As a learning experiment, concept mapping was well received by the students of Hope International School in Cambodia. However, executing the research remotely from Finland is not a functional solution, so the math syllabus must be first localized in Finnish condition. However, IGCSE provides past papers and solutions a free resource online, whereas in Finland the matriculation exams are not public. Moreover, the IGCSE math syllabus provides various descriptions, both verbal and more concise checklists, where only the essential concepts and rules are highlighted, which reduces the need for going through extensive amount of material, whereas in Finnish Curriculum the syllabus is more verbose, hence localization will require an extra effort, besides implementation.

Table 1. Modified TOGAF Enterprise Architecture of the Learning Artefact

	Motivation / Strategy	Information Architecture	Implementation / Tools
Conceptual level	**Student**: improve conceptual learning and give an overview of math, help in revising. Option of reviewing own development as well **Teacher**: assessment aid and learning analysis tool	Concept map as a GUI, authentication, questionnaires, auto-assessment, saving results, adding video tutorials (e.g. solutions for exercises) Key concepts are Math Syllabus Concepts to be learnt Actors: Teacher, Students	Implementation tools should support • Online use • User authentication • Integration with various systems and media
Logical level	Syllabus concept map as a tool for linking content to prior knowledge and revision Process1: Teacher introduces a new topic. First she shows a syllabus map and revises the prior knowledge to which she links the new knowledge Process2: As homework a student fills the questionnaire linked to the area, which adds to the grade Process3: A student reviews past paper exercises of the domain Process4: A student may upload a solution video to the exercise, which credits a bonus Process5: A teacher reviews the results of the whole class to be able to decide, whether it is time to move on Process6: A teacher assessed the class and uses conceptual development as one of the measures Process7: A student reviews his own development, e.g. past questionnaire results and time spent with each question	• Modeling domains of maths: 1. Number 2. Algebra 3. Functions 4. Geometry 5. Transformation & Vectors 6. Mensuration 7. Co-ordinate geometry 8. Trigonometry 9. Sets 10. Probability 11. Statistics • Activities types ○ Questionnaires ○ Past paper exercises ○ Student-made solution videos • Assessment model	Types of Tools • concept mapping • questionnaire • feedback • analyses Concept map as a GUI that contains links to the static collection pages. The content in the collection pages, however, is dynamic (cumulatively increasing)
Physical level		Database for storing assessment results (e.g. Google Spreadsheet)	Prezi, Google Classroom auth, Google Forms, Flubaroo, Google Spreadsheet, YouTube's non-public videos GUI + links to collection pages are static, every class should add questionnaires and video tutorials

3 Summary

The motivation for this research initiative is the identified gap in the concept possessing and having a limited overview of math. The sketched artefact should help in putting new concepts in place, linking them to the prior knowledge and revising. However, concept mapping should be introduced and used in parallel in other subjects as well, to strengthen the effect. We suggest a bigger cross-curricular concept mapping initiative, that would include English and ICT as well. In English, a concept map could be used as a parsing tool as suggested by Åhlberg (2002). In ICT students could be introduced to UML basics.

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O USO DO MAPA CONCEITUAL NA DISCIPLINA TEORIAS DE ENSINO E APRENDIZAGEM NO MESTRADO NACIONAL PROFISSIONAL EM ENSINO DE FÍSICA

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Resumo. Esse artigo relata uma experiência didática com alunos do Programa de Mestrado Nacional Profissional em Ensino de Física da UAG - Pernambuco, Brasil, na disciplina "Teorias de Ensino e Aprendizagem". Os alunos participantes são 9 professores de escolas particulares e públicas matriculados no programa. Neste contexto, foi desenvolvida uma unidade de ensino potencialmente significativa, cujas atividades centraram-se em perguntas foco sobre conteúdos da Teoria da Aprendizagem Significativa de Ausubel e elaboração de mapas conceituais, com o objetivo de contribuir para a melhoria da prática docente desses professores. Os mapas conceituais produzidos foram interpretados e comentados. Os resultados demonstraram que os mapas conceituais foram capazes de evidenciar a sua contribuição para a melhoria da prática docente, principalmente, quando centram o ensino na aquisição de significados e nos conhecimentos dos alunos, bem como, a Teoria da Aprendizagem Significativa permite interpretar as situações de ensino e aprendizagem que acontecem na sala de aula.

1 Introdução

O Mestrado Nacional Profissional em Ensino de Física (MNPEF) é um programa de pós-graduação, destinado a professores de Educação Básica, com polos distribuídos por Instituições de Ensino Superior no Brasil. O objetivo principal é capacitar professores em exercício quanto ao domínio de conteúdos da Física e de metodologias de ensino aplicadas à sala de aula. O polo da Unidade Acadêmica de Garanhuns da Universidade Federal Rural de Pernambuco (UAG/UFRPE) apresenta na grade curricular obrigatória do programa a disciplina "Teorias de Ensino e Aprendizagem", que discute diferentes abordagens teóricas sobre o processo de ensino e aprendizagem com ênfase na Teoria da Aprendizagem Significativa (TAS).

Parte-se do princípio que a TAS é uma teoria capaz de orientar o desenvolvimento de experiências metodológicas educacionais potenciais, facilitando a aprendizagem significativa (Ausubel, Novak & Hanesian, 1980). Apresenta como a variável mais importante do processo os conhecimentos prévios (Novak, 2010), além de centrar sua atenção na aprendizagem em sala de aula (Moreira, 2011a). No sentido de promover a compreensão sobre a TAS, e capacitar os alunos do MNPEF a fundamentar suas práticas docentes nos princípios básicos dessa teoria, desenvolveu-se uma unidade de ensino potencialmente significativa (UEPS), cujas atividades foram permeadas por perguntas foco e mapas conceituais (MCs). Assim, são relatados, neste artigo, alguns resultados parciais obtidos a partir do desenvolvimento dessas atividades.

2 Desenvolvimento Metodológico

Os Mapas Conceituais analisados nesse trabalho foram desenvolvidos pelos discentes da disciplina "Teorias de Ensino e Aprendizagem" do MNPEF. Para o desenvolvimento do conteúdo programático da disciplina foi estruturada uma UEPS contendo diversidade de atividades de ensino e avaliação (Moreira, 2011b). As perguntas foco que estimularam a elaboração dos MCs foram assim estruturadas: - O que é uma teoria? - O que é aprendizagem? - O que são teorias de ensino e aprendizagem? -. Os MCs produzidos são oriundos da leitura e discussão do texto "Aprendizagem Significativa: a teoria e textos complementares" de Moreira, (2011a, p. 13-55) e logo após, foram apresentados individualmente e essa dinâmica registrada em vídeo. Para concluir a atividade e avaliar o seu potencial significativo se propôs a seguinte questão: - "Qual é a importância e a contribuição dessa disciplina para o MNPEF ?"

Os MCs foram construídos através do software CmapTools (Cañas et al, 2004; Novak & Cañas, 2007). A construção e apresentação dos MCs serviram de base para as interpretações e comentários que estão registrados nos resultados e discussão. A avaliação dos MCs, seguiu critérios qualitativos sobre o aprendizado em termos conceituais, ou seja, como o aluno estruturou, hierarquizou, diferenciou, relacionou, discriminou e integrou os conceitos do conteúdo trabalhado (Novak 2010, Moreira, 2011a). As respostas à questão final estão registradas nos resultados e discussão.

3 Resultados e Discussão

Os resultados das perguntas iniciais, de modo geral, evidenciam o entendimento dos alunos sobre teoria: ... *são princípios, opiniões, ideia, hipótese, conhecimento, observação, análise de um algum tema que se propõe explicar*. Sobre o questionamento do que é aprendizagem, responderam: ... *é um processo, método, aquisição de saberes, conhecimentos, relacionados ao modo de aprender*. Ao responder sobre a questão – Os que são Teorias de Ensino e Aprendizagem afirmaram: ... *são várias formas de ensinar; é o modo de ensinar e aprender; são construções criadas pelo homem; é um conjunto de saberes para a prática docente*.... As respostas sobre a importância e a contribuição da disciplina "Teorias de Ensino Aprendizagem" no mestrado profissional, estão exemplificados nas opiniões de A1, A2 e A3 e são capazes de evidenciar o que eles pensam sobre o assunto.

Na maioria das respostas nota-se o reconhecimento da contribuição da disciplina "Teorias de Ensino e Aprendizagem" para o MNPEF, conforme destacado nos exemplos: *...Contribuiu positivamente para o desenvolvimento da minha aprendizagem e prática profissional...* (Aluno A1);*... A contribuição foi enorme... obtive informações imprescindíveis para o meu enriquecimento pessoal sobre o referencial teórico do meu trabalho final...*(Aluno A2); *... foi fundamental para embasar o início do curso, pois, aprendemos a trabalhar com duas ferramentas que facilitarão bastante não apenas o decorrer do curso como também ao longo de nossas vidas profissional... a contribuição mais importante será ... durante a construção da minha dissertação, ... será fundamentada em Ausubel, Novak e Moreira*"... (Aluno A3).

3.1 Interpretação do Mapa Conceitual Elaborado pelo Aluno A1

O MC desenvolvido pelo aluno A1 pode ser observado na Figura 1. A fala de A1 sobre o mapa da Figura 1: *"Professora a Teoria de Ausubel é o meu conceito principal, porque foi da criação dessa teoria que originou a ideia central desse teórico, que é o conceito de Aprendizagem Significativa. O que mais chamou minha atenção nessa teoria é o fato de ter como fundamento o ensino e a aprendizagem que acontece dentro da sala de aula. Além disso, a aprendizagem significativa, leva em consideração os conhecimentos prévios dos alunos, conhecimentos estes que se ligam aos subsunçores que podem criar novos conhecimentos que irão se relacionar aos conhecimentos prévios. Hoje eu consigo ver a importância desses conhecimentos prévio professora, porque é ele quem vai nortear o meu ensino. Esses novos conhecimentos podem ocorrer de várias formas, como a aprendizagem subordinada, a superordenada e a combinatória. A aprendizagem significativa na forma subordinada, leva ao princípio da diferenciação progressiva, enquanto que a aprendizagem significativa nas formas superordenada e combinatória leva a reconciliação integrativa. Quando eu elaborei e estruturei meu mapa não tive essa ideia de como fazer essas ligações entre as formas de aprendizagem, mas agora ao apresentar eu vejo várias dessas possibilidades, por isso que eu estou falando".*

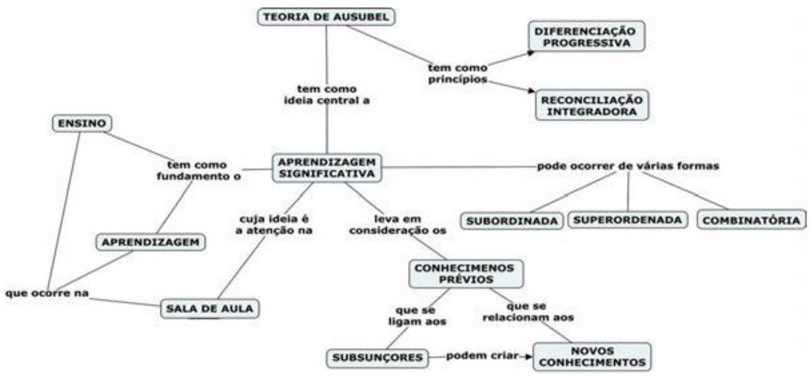

Figura 1: Mapa conceitual, Aluno A1, sobre os principais conceitos integradores da TAS.

3.1.1 Comentários do Professor, Figura 1, MC A1

Percebe-se que A1 foi claro e seguro nas respostas aos questionamentos feitos durante a sua apresentação. Nesse contexto, a importância da apresentação oral de A1 foi fundamental para percebermos que mesmo não constando em seu mapa as observações ditas, viu que essas relações poderiam ser feitas, pois nele estaria atribuindo significados aos conceitos em questão (Ausubel, Novak e Hanesian, 1980). As relações entre os conceitos e as proposições formadas por A1, e as explicações dadas que não constavam no mapa, demonstrou a capacidade de diferenciar progressivamente e reconciliar integrativamente os conceitos da TAS, ampliando na sua estrutura cognitiva espaços para consolidação de novos conceitos (Ausubel, 2000).

3.2 Interpretação do Mapa Conceitual Elaborado pelo Aluno A2

O MC desenvolvido pelo aluno A2 pode ser observado na Figura 2. A fala de A2 sobre o mapa da Figura 2: "*O construtivismo de Ausubel para mim professora, foi o conceito mais geral. Esse conceito tem como ideia central a aprendizagem significativa, cuja preocupação é com a variável que ele considera mais importante, que é o conhecimento prévio. Esse conhecimento prévio consiste de subsunçores que ao interagir com os novos conhecimentos vai resultar na assimilação. A aprendizagem significativa se opõe a aprendizagem mecânica. A mecânica no sentido de ser arbitrária e literal ao pé da letra. Esses dois tipos de aprendizagem, não são dicotômicas, pois existe um contínuo entre elas, já a aprendizagem significativa se dá, de maneira não arbitrária e substantiva. O construtivismo de Ausubel, conduzido pela aprendizagem significativa apresenta como princípios programáticos a diferenciação progressiva, a reconciliação integrativa, a organização sequencial e a consolidação. A aprendizagem significativa pode ser representacional quando, por exemplo, temos em mente que um determinado conceito tem uma representação única só para nós, isso significa que o conceito não foi compartilhado com outras pessoas. A aprendizagem significativa conceitual ocorre por assimilação do novo conhecimento que vai ancorar nos subsunçores... e a aprendizagem significativa subordinada é aquela em que o novo conhecimento se ancora nos subsunçores... a aprendizagem significativa superordenada ocorre quando por exemplo eu faço uma ligação cruzada válida no meu mapa*".

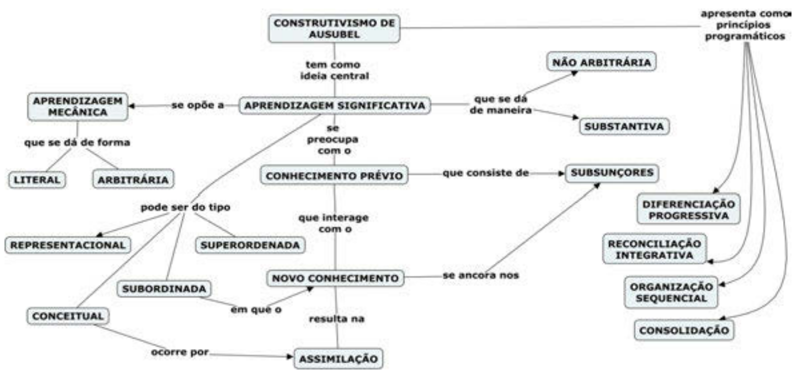

Figure 2. Mapa conceitual, Aluno A2, sobre os principais conceitos integradores da TAS.

3.2.1 Comentários do Professor, Figura 2, MC A2

Na apresentação do mapa de A2 percebeu-se que as informações apresentadas em termos conceituais foram ampliadas em relação ao mapa do aluno A1. Porém o aluno A2, seguiu a risca o que estava escrito no seu mapa, até o momento em que ele expunha os tipos de aprendizagem. A partir daí, ele exemplificava os tipos de aprendizagem e respondia aos questionamentos dos colegas. O exemplo dado por ele sobre a aprendizagem superordenada foi muito pertinente "ocorre quando por exemplo. eu faço uma ligação cruzada válida no meu mapa". Contam Gowin e Alvarez (2005) que estas relações indicam raciocínio, capacidade criativa e compreensão do tema.

3.3 Interpretação do Mapa Conceitual Elaborado pelo Aluno A3

O MC desenvolvido pelo aluno A3 pode ser observado na Figura 3.

A fala de A3 sobre o mapa da Figura 3: *"Professora, meu mapa está resumido porque eu procurei colocar, no meu entendimento, os conceitos mais relevantes da teoria. Eu comecei com o conceito chave Cognitivismo que para mim um dos mais importantes representantes que eu aprendi aqui nesse curso foi o Ausubel. E graças a Deus professora, que ele propôs a teoria da Aprendizagem Significativa que inicia a partir dos conhecimentos prévios e tem como ator principal o aluno. Porque eu vejo Professora que os conhecimentos prévios é que vai me dizer como vou iniciar e planejar minha disciplina. Eu vejo uma importância muito grande sobre esses conhecimentos prévios que tem o professor como mediador do aluno e ao mesmo tempo, esse professor deve fazer uso de materiais potencialmente significativos para alcançar a aprendizagem significativa ao avaliar como seus alunos estão adquirindo os significados do que está sendo ensinado. Outra coisa muito importante que eu vi na teoria são os princípios da diferenciação progressiva e da reconciliação integrativa. Porque além de serem muito importantes são dependentes um do outro, um não existe sem o outro. Foi isso que eu entendi Professora*".

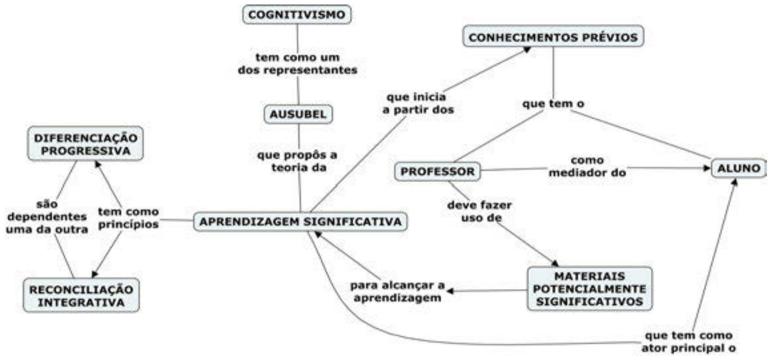

Figura 3: Mapa conceitual, Aluno A3, sobre os principais conceitos integradores da TAS.

3.3.1 Comentários do Professor, Figura 3, MC A3

O mapa do aluno A3, em relação aos mapas de (A1 e A2) apresentou uma quantidade de conceitos sobre a TAS inferior, porém todos os conceitos e proposições formadas são relevantes para o contexto da matéria de ensino. Nota-se a ênfase dada pelo aluno aos conhecimentos prévios. Ausubel sugere que o conteúdo da disciplina seja planejado de acordo com esse conhecimento prévio apresentado, apesar de sabermos que estes conhecimentos tanto podem facilitar quanto impedir novas aprendizagens (Ausubel, Novak & Hanesian, 1980). Na apresentação A3 demonstrou domínio do conteúdo, conseguiu formar relações cruzadas e horizontais importantes, realizou a diferenciação progressiva e a reconciliação integrativa.

4 Considerações Finais

Considera-se que objetivo do trabalho e das atividades desenvolvidas sobre os conteúdos relativos a TAS, centrados nos Mapas Conceituais foi alcançado uma vez que esse conteúdo favoreceu a construção dos principais conceitos integradores da referida Teoria. Os alunos apontam que o foco desse programa de mestrado está na aprendizagem significativa, como uma grande contribuição para a melhoria de suas práticas docente, quando centram o ensino na aquisição de significados, nos conhecimentos dos alunos, além de usar a teoria para interpretar as situações que acontecem na sala de aula. Do mesmo modo, as unidades de ensino Potenciais, em particular o mapa conceitual, foram consideradas de grande importância, para o aprendizado dos conteúdos da matéria de ensino.

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PROPUESTA DE MODELO EDUCATIVO USANDO APRENDIZAJE SIGNIFICATIVO PARA LA CARRERA DE INGENIERÍA EN COMPUTACIÓN IPN, MÉXICO

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Abstract: Este artículo presenta la propuesta de un nuevo modelo educativo con la experiencia del Aprendizaje Significativo con el uso de mapas conceptuales en la Carrera de Ingeniería en Computación incorporando 4 elementos clave que nos solicita la institución a la que pertenecemos y los casos de éxito al ser aplicados desde hace tiempo. El desarrollo de mapas conceptuales favoreció a los estudiantes para desarrollar actividades dentro y fuera del salón de clases, así como, herramientas y materiales mediante TIC´s de forma autónoma, entre pares y para pares de futuras generaciones. Describe su potencial como instrumento curricular y de facilitación del conocimiento que revela la calidad de los procesos de aprendizaje con el fin de permitir que el profesor pueda ajustar el trabajo pedagógico en la superación de las dificultades de los estudiantes, las incorpore apropiándose de ellas con la confianza en la homologación del conocimiento preparando material significativo. También con ésta propuesta se reafirma la presencia de un sujeto activo, auto organizador y reconocedor del cambio como una condición intrínseca para cualquier aprendizaje.

1 Introducción

Hoy en día el sector educativo presenta cambios que la sociedad ha ido exigiendo como: estar en un marco que no discrimine e integre estrategias que permitan aprender significativamente y para toda la vida, desarrollarse y cumplir ampliamente los requisitos del campo laboral de manera integral, que exista congruencia respecto al orden de exigencia global al mismo tiempo que localmente y de acuerdo al entorno y necesidades pertinentes que lo envuelven. Todo esto ha propiciado un cambio de enfoque respecto al contenido curricular de prácticamente todas las áreas y niveles de la educación. En los últimos años, la tecnología se ha convertido en un factor que avasalla casi todos los campos. Ante la necesidad de un modelo de enseñanza que le lleve el paso a este desarrollo tecnológico tan acelerado, el uso de la misma, se convierte en una poderosa razón para reflexionar que, es a través de ella que se puede llegar a innovar el aprendizaje y la enseñanza en muy diversas áreas curriculares y niveles educativos (Veloz. et al, 2010).

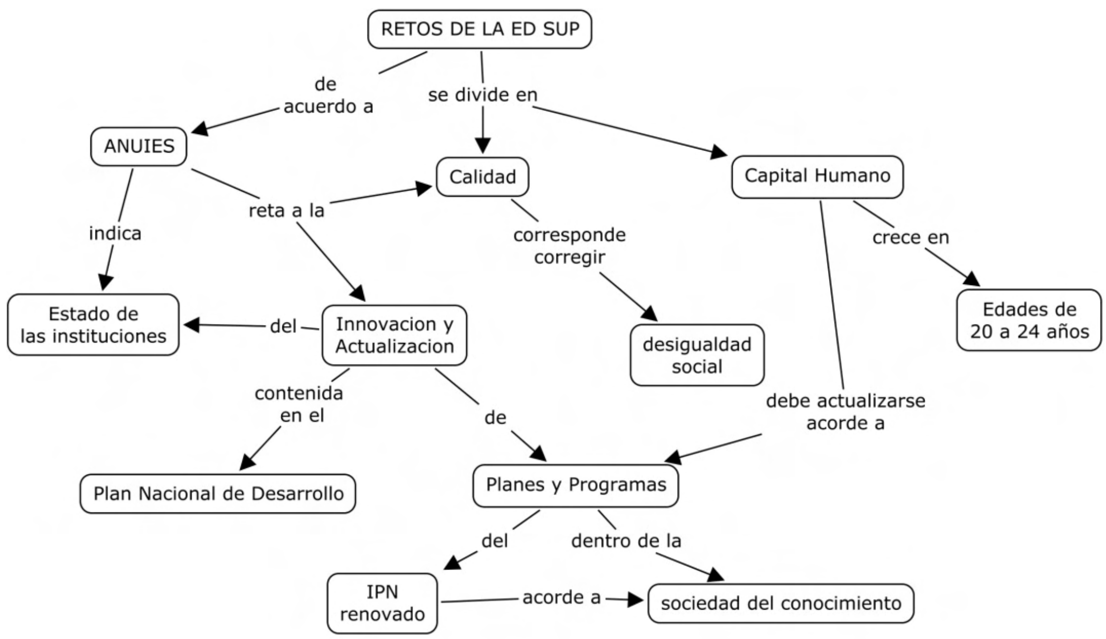

Figura 1. Mapa conceptual de la educación superior del IPN México (Veloz 2016).

2 Desarrollo

Partiendo del Nuevo Modelo Educativo (NME) proponemos una nueva concepción del proceso educativo promoviendo una formación integral y de alta calidad, orientada hacia el estudiante y su aprendizaje. Para lograr esto emplearemos programas formativos flexibles que incorporen la posibilidad de tránsito entre modalidades, programas, niveles y unidades académicas, así como la diversificación de los espacios de aprendizaje y la introducción de metodologías de enseñanza que otorguen prioridad a la innovación, la capacidad creativa y el uso intensivo de las TIC como lo es el Aprendizaje Significativo (Veloz et al, 2011). junto con la teoría de la Tecnología de la Educación*,* derivando en iniciativas nuevas para el proceso de enseñanza aprendizaje con énfasis en la educación superior (González et al, 2007).

2.1 Aprendizaje Significativo (AS)

Ausubel (1963, 1968, 2000) y Ausubel, Novak y Hanesian (1978) han distinguido claramente entre el aprendizaje como repetición mecánica en la que se reciben nuevos conocimientos de manera casual, y cuyo contenido no se incorpora en la estructura cognoscitiva o esquema mental (ahora diríamos en la memoria a largo plazo, o MLP) del individuo, y el aprendizaje significativo, donde el discente integra de manera refleja el nuevo conocimiento adquirido en los que posee de antemano situación.

Así, un elemento clave para conseguir el AS será, la elaboración de un material curricular e instruccional conceptualmente transparente para ayudar a modificar las estructuras cognitivas del alumno y junto con docentes responsables que cambien la dinámica de trabajo en el aula y fuera de ella promoviendo la construcción del conocimiento y compartiendo resultados, estos usaran los conceptos y significados que ya internalizaron para captar los nuevos e incluirlos en su estructura cognitiva (esquema conceptual). De aquí que el NME incluirá 4 elementos sugeridos clave (Eficiencia, Tolerancia, Equitativa y de Relevancia) manejados mediante la propuesta descrita y explicada en el MMCC de la figura 2 abajo indicada.

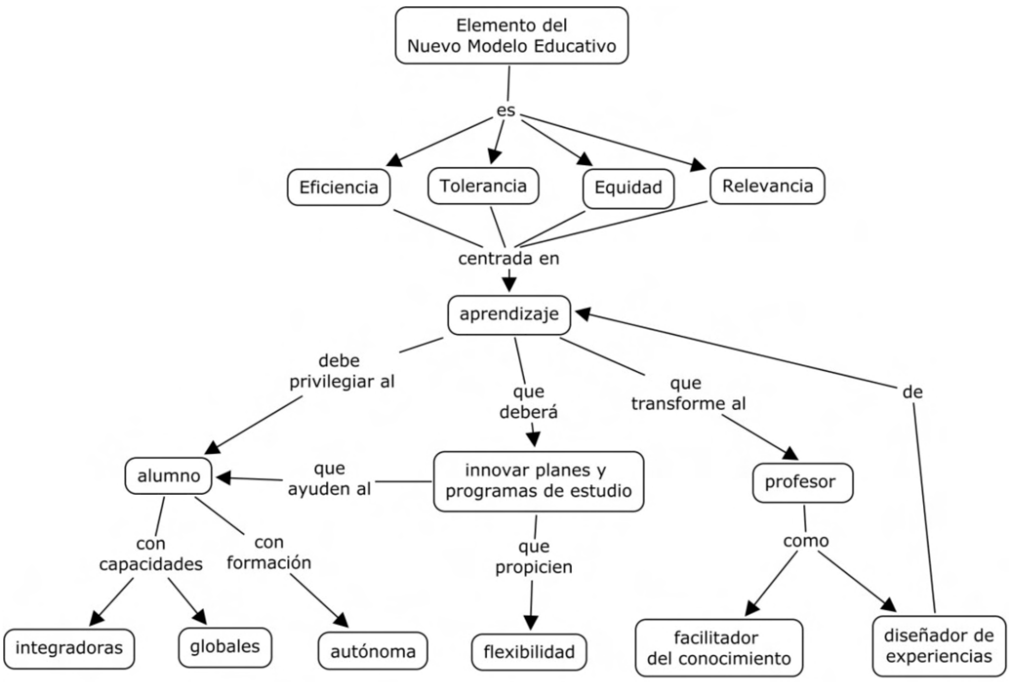

Figura 2. Mapa Conceptual del Nuevo Modelo Educativo Del IPN (Veloz, 2016).

2.2 Tecnologías de la Información y Comunicación (TIC)

Por otra parte, las nuevas tecnologías se centran en los procesos de comunicación, estos por consecuencia, evolucionan en promotores de cambios sociales, económicos y culturales como lo han demostrado los últimos acontecimientos en países como Egipto, Siria y Brasil, entre otros. Al ser un fenómeno tan reciente (40 años) y tan cambiante, merece una atención especial por el sector educativo; analizando, estudiando y comparando, su praxis, orientación y derivación, de la misma forma, es decir, "también en poco tiempo". Los cambios experimentados en las dos últimas décadas y, como consecuencia, los desafíos que plantea la SCN y las TIC requieren la necesidad de una rápida e inteligente reacción del sistema educativo. Pocos son quienes dudan de que el rol clásico del profesor tiene que cambiar para adaptarse, así, mediante la utilización de herramientas informáticas e internet generamos personas con posibilidad de trabajar en forma autónoma, flexibles, críticas, capacitadas para dar respuestas rápidas a las cuestiones presentadas y con elevada autoestima (González, Guardián, Veloz, Rodríguez, Veloz, & Ballester, 2011). También existe una cantidad muy vasta de trabajos relacionados con nuevos modelos y estilos de aprendizaje e instrucción de trabajo cooperativo y/o colaborativo; algunos usando técnicas informáticas y TIC, con algún material multimedia o visual diseñado para el propósito particular requerido (Leiva, Chrobak, 2004; Andreanna, Marida, Vasilis. Komis & Vasiliki, 2010).

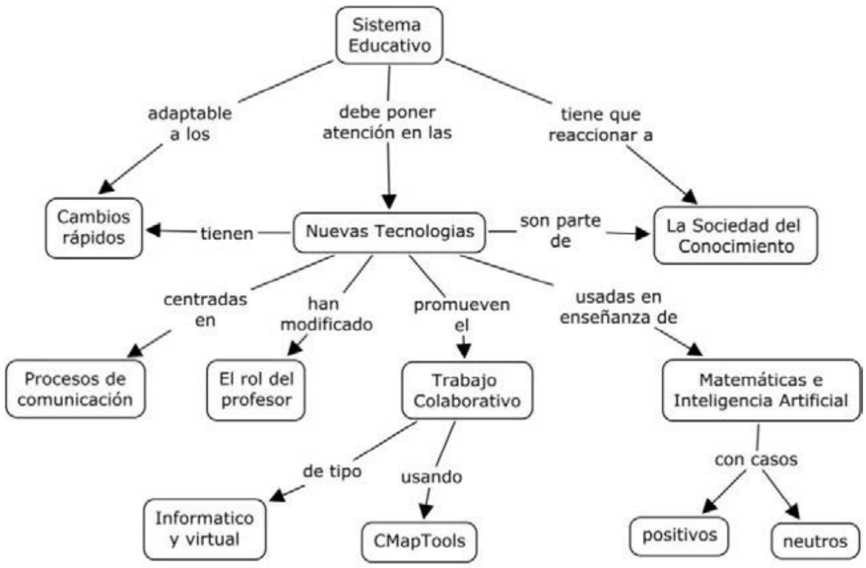

Figura 3 Mapa Conceptual del Sistema Educativo Propuesto. (Veloz, 2016).

3 Conclusión

Actualmente el grupo de profesores (10) que trabajamos impartiendo diversas asignaturas mediante este plan evidenciamos un cambio en los grupos experimentales, tanto en las actitudes sobre todo al ser sumamente positivas y motivadoras, así como, en el rendimiento académico, con notable homogeneidad aun a pesar de recibir alumnos sumamente heterogéneos. También en lo que respecta al pensamiento divergente se revela el aprendizaje significativo, al surgir en las producciones de los alumnos la creatividad en expresiones, producciones, y estudios de la vida real y compartirla mediante TICs generadas por ellos para pares y generaciones futuras.

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SCIENTIFIC LITERACY: FOURTEEN YEARS OF TEACHING (2001–2015) WITH CMAPTOOLS

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Abstract. At the end of my first fourteen years of teaching, pupils of my classes built about 2000 concept maps (Cmaps). Cmaps were the tether of any proposed teaching–learning; moreover, they brought to a more effective way of teaching and, as it is showed by the surveys, they have favored the formation and the location of my former pupils. The following summing maps are the small example of the extensive learning path, done in a class with 18 pupils about 10–11 years old during 2002.03 school year. Our starting map shows the representation of a hypertext, realized through CmapTools. We start with the word Interaction, one of the five key–words (Object, property, material, interaction, system) of the pilot project by the Ministry of Education, called "Scientific Literacy". The mentioned project has even developed in Bosnia. The schools which cooperate in the net in the town of Breza are actually 5 (2016).

1 Introduction

In our classes it was created a multidisciplinary educational path through CmapTools software (Cañas et al. 2004), with the aim to offer to the pupils the opportunity to elaborate any concept as widely and transverse as possible, going over the most stringent disciplinary subdivisions. This work was a challenge for us, teachers: we had to manage working together, putting on the field all our competences, to discover all the educational potential Educational software. It was a good way, for the pupils, to consolidate the capability to elaborate concept maps and improve computer skills. Pupils, through the use of the software, had the opportunity to document, link, display and summarize personal and cooperative learning paths. The work of each was a piece of the overall picture, and has grown in value because inserted in a broader context. The concept word Interaction, of the project Science offered the opportunity of multiple reflections and multidisciplinary and interdisciplinary links. Maps and connected hypertexts, inserted inside the main concepts, are the product of individual and cooperative work of pupils in all school years 2001–2015. The map which follows is the 'Mother Map' of the work of one school year.

2 Concepts and Maps

Pupils, first of all, understood the word interaction, in the science context, thanks to the previewed experimental activities, then they applied in other contexts. For example, there had been a research about interaction in human body, about Italian language, in Geography, with the interaction between man and environment, finally in History studying the effects produced by integration among populations.

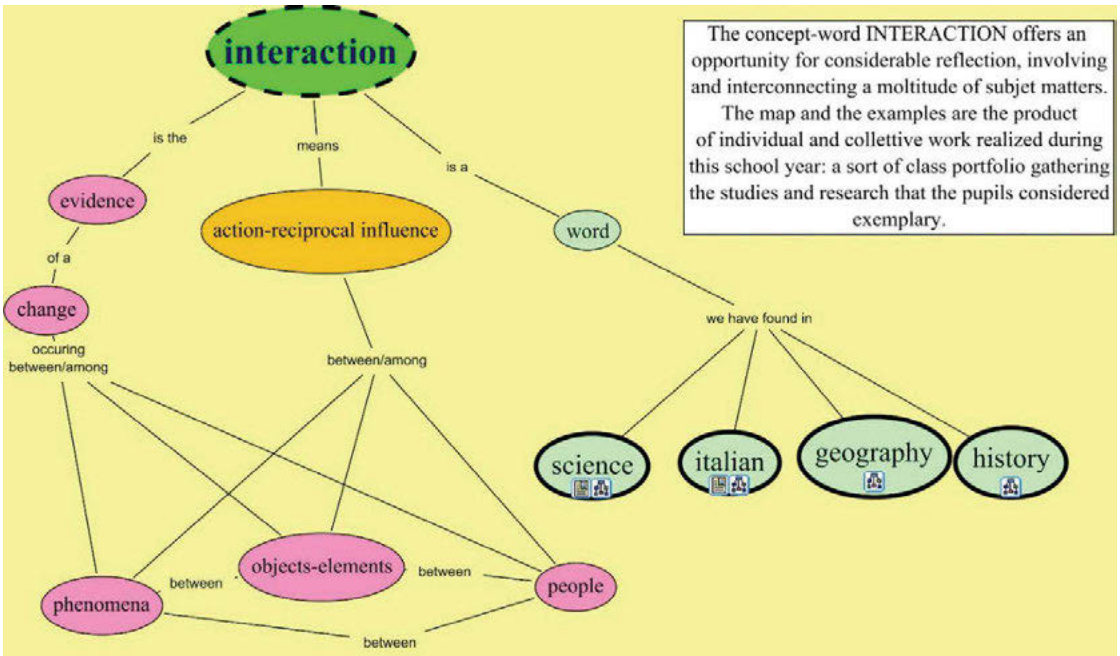

Figure 1. Mother Map from which the whole hypertext starts.

Thanks to CmapTools it is possible to recuperate, organize and reserve all the knowledge, so that it will be not wasted.

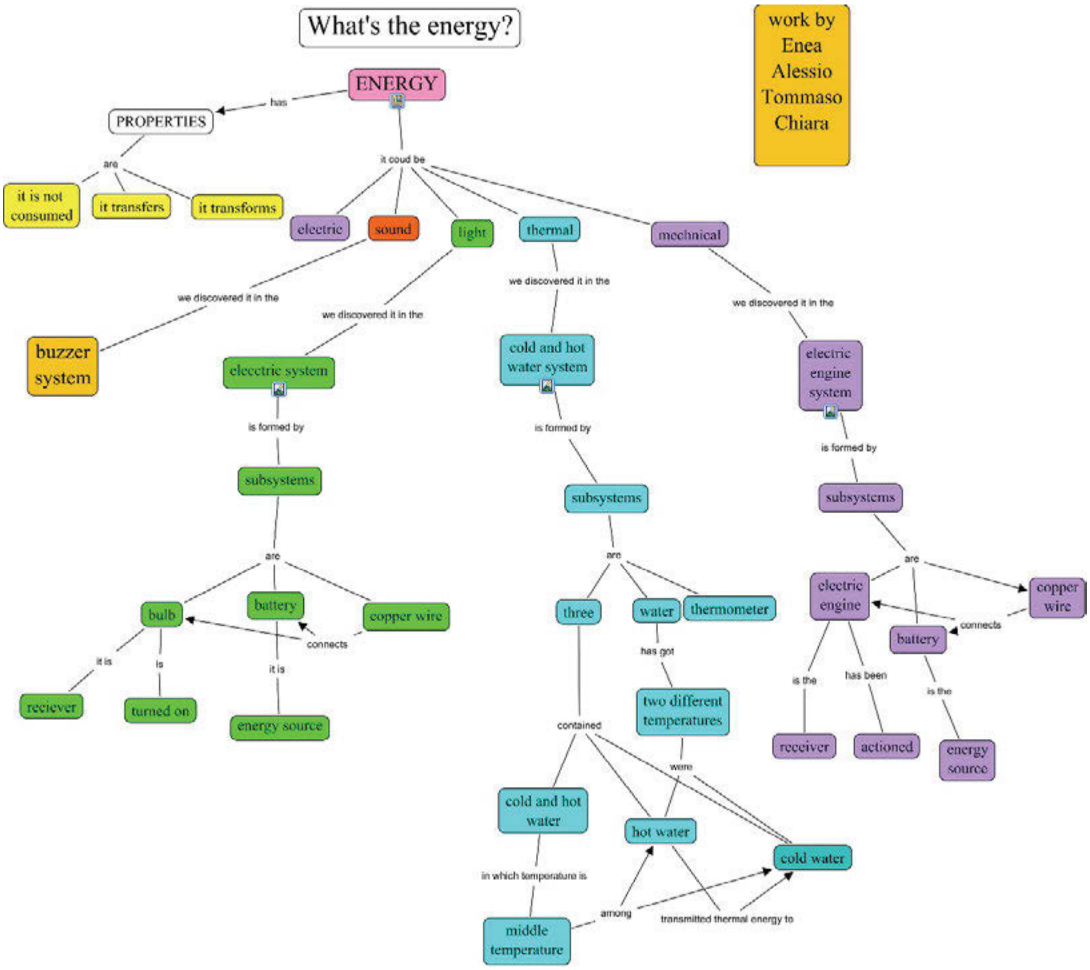

Figure 2. This is one of the 10 science Map in the Hypertext.

Another connected map tells the experiences that pupils had about Energy and about the use of the Concept word: ***System.*** the use of colours has a main importance since it makes immediately explicit the experiments done, which is possible to see by opening the referring connections. Thanks to the building of the concept map, pupils, in cooperative learning, could collect and share different experiences and then connect among them to reach the to reach the learning achievement of the complex concept of energy.

2.1 PowerPoint about Binomial Fantastic

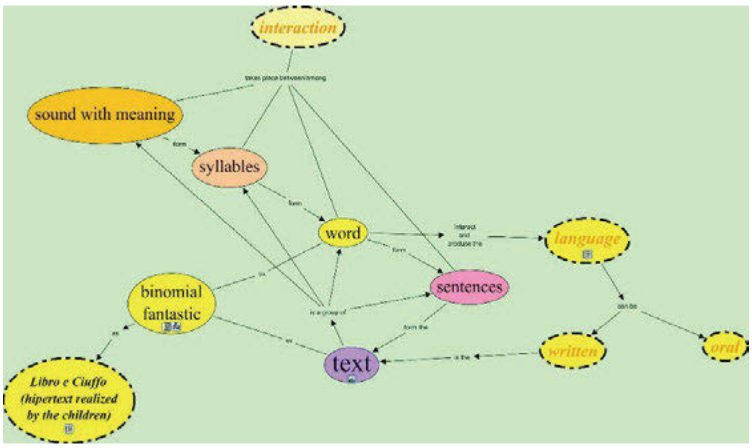

Figure 3. This is the map, which explains the possible interaction in the language.

This picture shows, indeed, some sources connected to the concept map about interaction, applied to the Italian language teaching. A map explains the fantastic combination by the author Gianni Rodari, another one explains what the language is. Finally, there is a story invented by the pupils through the system Fantastic Combination presented by/through Power Point.

Figure 4. This story was born from the interaction between the words: Book and Tuft of Grass, following the Binomio Fantastico (Binomial Fantastic) Method. This is the only one of 30 resources in the hypertext.

2.2 Concept maps and CmapTools: towards a successful model

Realization of hypertexts as this one, which connect among themselves more concept maps and different made possible the conquest of a transversal thinking mode, a non-common capability at this age and which enriched with meaning and creativity throughout the learning path. After this hypertext many other hypertexts followed this first one (either made by the class and by single pupils) based on different disciplinary activities, all this promoted an active and stimulating learning environment.

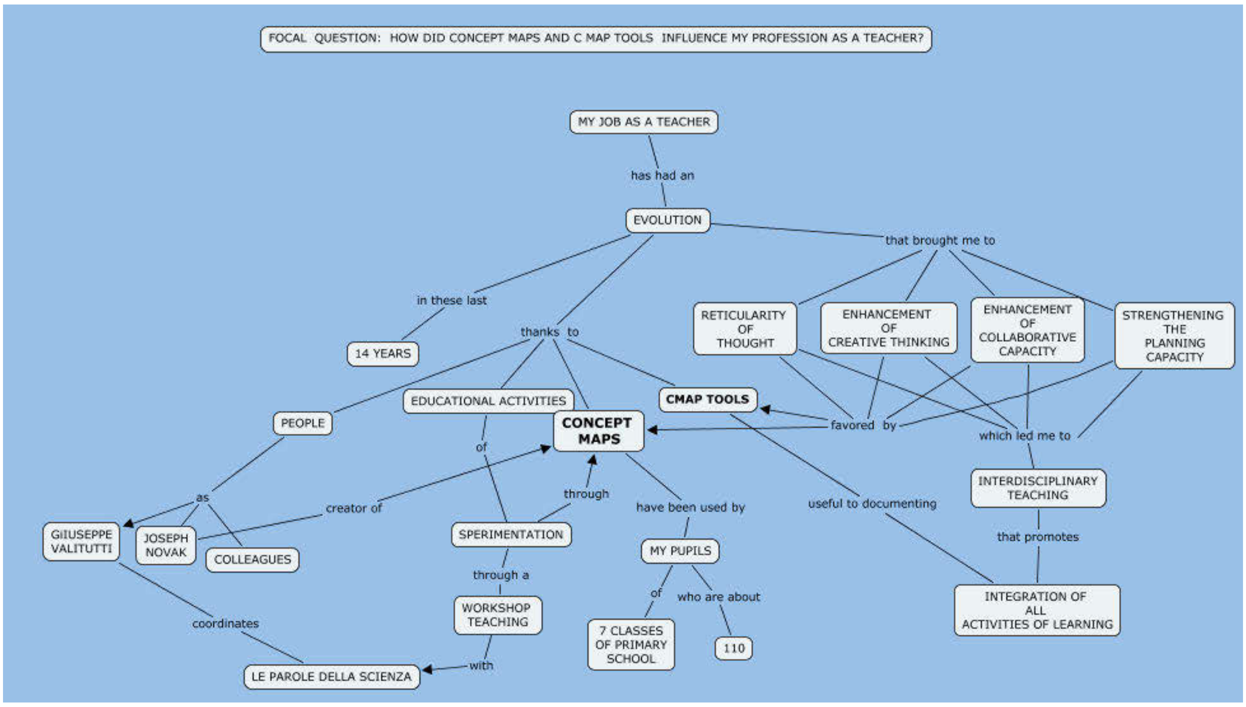

Figure 5. This map summarizes how I changed my way to do school thanks to concept maps and CmapTools.

After a research I recently did on a sample (65%) of my former pupils, who are actually between 18 and 24 years old, have emerged significant data showing that the concept maps had a positive influence on their education and personal training.

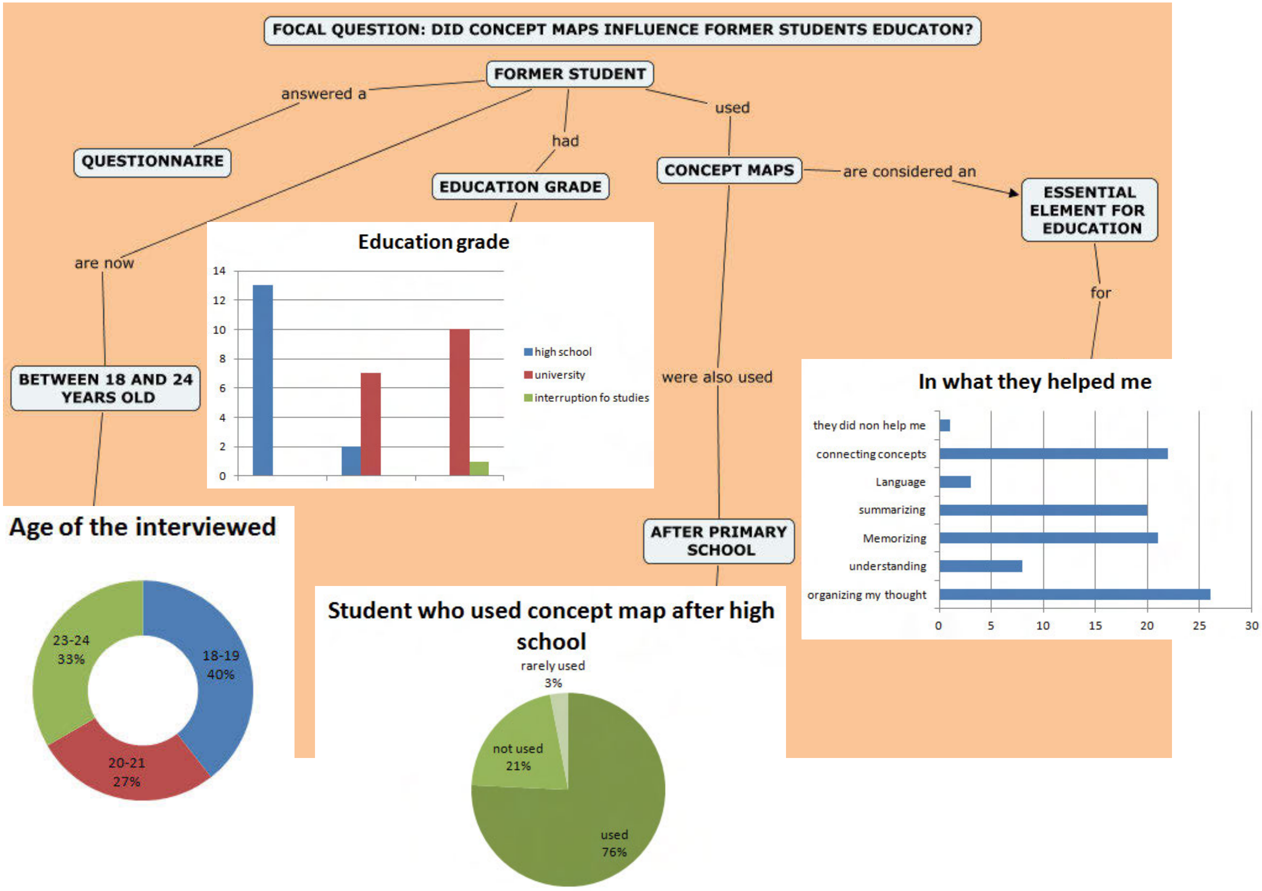

Figure 6. This map summarizes investigation results.

All the pupils, except one, continued their education after compulsory school. The 18–19 years old group is actually busy in the final exams, most of the others are attending University, some have already graduated. 76% went on choosing concept maps as a preferred learning tool "*for more effective way of study*" Tommaso; "*To study and take notes*" Chiara; "*To organize a speech*" Maria Chiara; "*to address an amount of challenging study and complex concepts"* Enea; "*to organize my final thesis"* Giuditta; "*to develop projects"* Francesco; "*always build a map before a query"* Francesca; "*I start from the title to build a concept map so than it could summarize all the aspects and most important points of my research"* Francesco; "*to summarize and better fix all the concepts. It is useful to repeat and highlight any main topic"* Luigi; "*to summarize and highlight any study topic"* Elisabetta; "they *helped me a lot to reach a solid security and a deeper comprehension af all the topics"* Annalaura.

According to my former pupils, concept maps are very important since these mainly allow to organize their thought, they help to memorize and connect all the concepts, then they can simplify the synthesis; a very few amount of them think that maps could help the strengthening of language. Even all those who do not use maps anymore think that, when these were used in the primary school, they have been useful for their training/learning process.

3 Summary

Concept Maps and the use of CmapTools have proved to be decisive in the conquest of an effettive model of teaching and learning.

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THE INFLUENCE OF GRAPHICAL OR TEXTUAL REPRESENTATIONS ON TEAM CONCEPT MAP FORM: FURTHER VALIDATION OF A MEASURE OF KNOWLEDGE STRUCTURE

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Abstract. This descriptive investigation seeks to extend our application of graph theoretical measures of knowledge structure (KS) by considering the question: How do graphical versus textual lesson materials influence team concept map form? To answer this, 80 team concept maps on a woodland infestation from two previous studies were reanalyzed using innovative node degree similarity measures. Lesson materials were either graphical (partial maps in a hidden profiles paradigm) or textual (propositional statements that compose those partial maps). Triads working online at a distance used the lesson materials to create a team concept map with or without awareness of the other triad members' knowledge information. As expected, the team maps derived from the graphical materials were far more like the expert and solution benchmark maps relative to the textual team maps. Also, the graphical condition led to more similar team maps (team convergence of about 51% and 55% overlap) relative to the textual condition (27% and 49% overlap). These results align with expectations and thus further validate this technology-based approach for measuring knowledge structure in lesson artifacts in order to better understand the mediating influence of lesson tasks on learning processes and outcomes.

1 Introduction

An important aspect of science is concept inter-relatedness, called structural knowledge (Goldsmith et al., 1991; Ifenthaler, 2010; Jonassen et al., 1993) and also just knowledge structure (Clariana, 2010). Measuring and assessing the knowledge structure (KS) of individuals and teams requires the capturing and analysis of key latent variables (Johnson et al., 2006). Conceptually, KS implies relationships patterns that can be represented as networks; several classes of weighted association networks provide a well-established toolset for capturing, combining, analyzing, representing, and comparing KS (Clariana, 2010).

Concept maps are a well-established measure of learning that can capture different aspects of knowledge (Ruiz-Primo, 2004) including KS (Clariana, 2010). The concept map analysis approach applied in this current investigation has been used previously to measure KS – of American students learning social science principles (Clariana et al., 2015), of German students solving pesticide problems (Clariana et al., 2013), of Dutch school children learning ecology (Fesel et al., 2015), of Dutch/English bilinguals learning archeology from English lesson materials (Mun, 2015), and of Korean/English bilinguals learning archeology from English lesson materials (Kim & Clariana, 2015). The current investigation involves German undergraduates working online in triads to create team concept maps.

This investigation seeks to further validate and extend this concept map KS measurement approach by applying it to address the question: How do graphical versus textual lesson materials influence team concept map form?

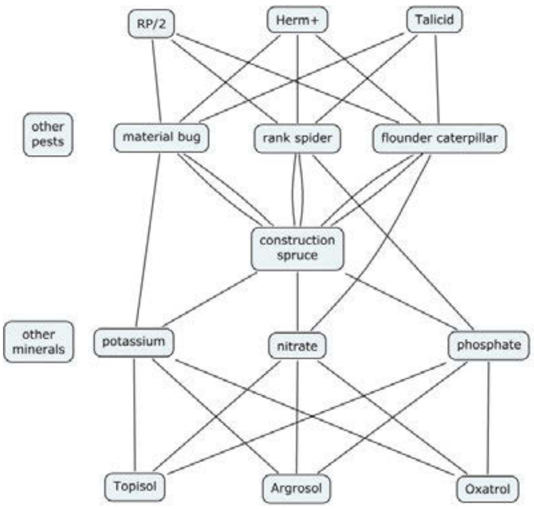
2 Methods and Results

This descriptive quasi-experimental investigation reanalyzed 80 team-created concept maps from a previous study of Engelmann and Hesse (2010) that used graphical lesson materials and from the follow-on study of Engelmann et al. (2014) that used equivalent textual lesson materials. Those two studies are otherwise identical except for the textual or graphical lesson materials. Also the precise details of the methodology are available in those two published papers, but in brief, participants were recruited from a German university with a monetary incentive; as they randomly arrived at the site, they entered separate cubicles alone and worked online in triads connected using skype audio and the CmapTools (Cañas et al., 20014) mapping tool to create a shared team map.

These two studies considered theoretical and practical issues related to content-based knowledge awareness (CoKA) in transient collaborative groups. The CoKA construct is derived from the literature base on shared mental models, common ground, and transactive memory systems. Thus the triads were randomly assigned to either a treatment condition where team members are able to see the other triad members' lesson materials or the control condition where they were not able to see the others' lesson materials. In their individual lesson materials, each member of the triad received either a partial concept map or equivalent text materials with some common information and also about 1/3rd of the total information that described a woodland infestation and possible solutions, all three portions taken together are needed to solve the infestation problem (a hidden profiles paradigm); thus 40 teams received graphical information and 40 teams equivalent textual information as propositional statements derived directly from the graphical information. Since each team created one joint team concept map in the shared virtual space, the data for this reanalysis consists of these team maps.

2.1 Convergence with Referent Maps

Using only the 15 key terms, all of the team maps were converted to 15-element node degree vectors (see Figure 1), then each team map vector was correlated with an expert map vector that contained all of the information and also with a solution sub-map vector that only had the information needed to solve the pesticide problem. Since r values are not interval data, then these r values were transformed to Fisher Z and averaged, also the estimated percent overlap of the maps is calculated as Pearson r squared of the Fisher Z inverse (see Table 1).



	Expert	Solution
construction spruce	9	6
rank spider	6	4
material bug	6	3
flounder caterpillar	6	0
nitrate	5	2
phosphate	5	2
potassium	5	0
RP/2	3	2
Argrosol	3	1
Herm+	3	0
Oxatrol	3	0
Talicid	3	0
Topisol	3	0
other minerals	0	0
other pests	0	0

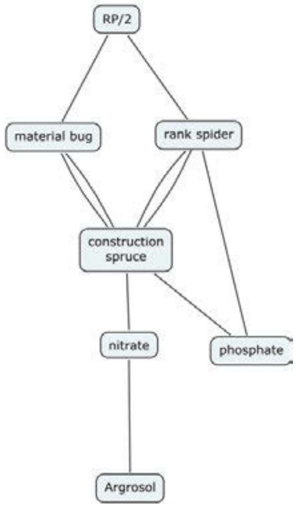


Figure 1. The full Expert map (left panel) and the Solution map (right panel) along with the node degree table for each map.

		to Expert map	to Solution map
textual	treatment	0.91 (0.46); 52.0%	0.61 (0.36); 29.6%
	control	1.26 (0.63); 72.4%	0.62 (0.37); 30.4%
graphical	treatment	1.25 (0.59); 72.0%	0.95 (0.33); 54.7%
	control	1.42 (0.62); 79.1%	0.79 (0.30); 43.4%

Table 1: Team map similarity to the expert map and to the solution sub-map as Fisher Z means and standard deviations (in parenthesis) and as map percent overlap for each condition.

This Fisher Z data were analyzed by a 2 x 2 x 2 repeated measures ANOVA, with the between subjects factors lesson form (graphic or text) and knowledge awareness treatment (can or cannot see peers' screens) and with the repeated measure similarity to the expert map and to the solution sub-map. The main effect for lesson form (as graphic or text) was significant, $F(1,76) = 7.407$, $MSe = 0.340$, $p = .008$; not surprisingly, the team maps based on the graphical lesson forms relative to those based on the textual lesson form were substantially more similar to the expert's map (Fisher $z = 1.34$ vs. 1.09; 76% vs. 63% overlap with the expert) and to the solution map (Fisher $z = 0.87$ vs. 0.62; 49% vs. 30% overlap with the solution). Also the interaction of the repeated measure similarity to the expert map and to the solution map and knowledge awareness was significant, $F(1,76) = 9.953$, $MSe = 0.108$, $p = .002$ (see Figure 2), however, although follow-up analysis of this interaction revealed no significant findings, the control group that had only their own map, the developing team map, and audio contact with their triad members developed triad team maps that were more fully developed and similar to the expert map. In contrast, the triad team maps in the knowledge awareness condition were less fully developed and tended to be more solution oriented.

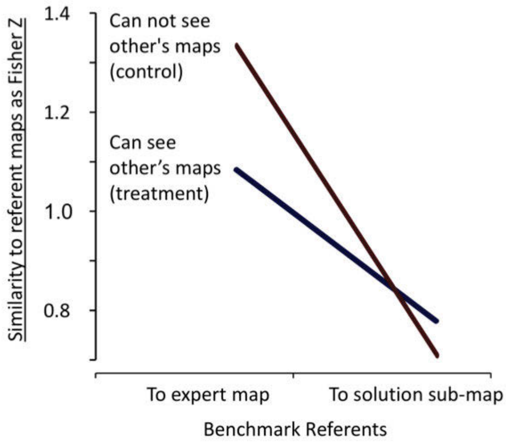


Figure 2. Significant interaction of team map similarity to the benchmark referents and knowledge awareness.

2.2 Team Convergence

Team convergence here is a measure of how similar team maps are to each other, rather than to the expert or solution maps described above. To measure team map convergence, each team map node degree vector was correlated to *every* team map vector, and the obtained Pearson r values were transformed to Fisher Z values and then averaged across all conditions, including lesson form and knowledge awareness (see Table 2). The diagonal in the table indicates with-in condition similarity while the off-diagonal compares team maps across conditions. Regarding with-in team map similarity, the teams that received graphical materials and could not see their members' screens (no CoKA) attained the most similar within-team maps, with a 55% average overlap, relative to the teams that received textual materials and could see the members' screens (KoCA) attained the least similar team maps, with a 27% average overlap. Regarding across-team map similarity, in every case, triad team member knowledge awareness (CoKA) led to *less similar maps* relative to their complementary group that is without such content knowledge awareness (control). Perhaps CoKA engenders greater within triad expression of idiosyncratic individual mental models? It remains to be determined whether CoKA leads to mental model convergence of members in the same team, but these results show that team maps developed with content-based knowledge awareness are relatively *less similar* to other team maps. Further, although not as striking as this CoKA influence, as would be expected the team maps derived from lesson concept maps generally were more similar to each other than team maps derived from lesson texts.

	Textual		Graphical	
	can see	can't see	can see	can't see
Textual – can see	**27%**	38%	35%	36%
Textual – can't see	38%	**49%**	45%	50%
Graphical – can see	35%	45%	**51%**	51%
Graphical – can't see	36%	50%	51%	**55%**

Table 2: Average team map convergence measured as percent overlap of team map node degree vectors.

3 Summary

The team maps derived from the graphical lesson materials were far more like the expert map and the solution benchmark maps relative to the textual lesson team maps. Also, the graphical lesson materials led to more similar team maps (e.g., team convergence of about 51% and 55%) relative to the textual lesson materials (27% and 49% overlap). The means that using concept maps as lesson materials engendered fundamentally different knowledge structures, relative to text-based lesson materials. This seems pretty important.

This investigation seeks to further validate and extend a concept map knowledge structure measurement approach. The observed results aligned with expectations and thus further validate this technology-based approach for measuring knowledge structure in team lesson artifacts in order to better understand the mediating influence of lesson tasks on learning processes and outcomes. The concept map KS measures used in this investigation are fairly easy to prepare and can be fully automated. Note for instance that it handles missing terms by using a zero in the vector element. Further, CmapTools could be easily modified to output map node degree data like this that can then be compared to expert referent maps and also to other team members' maps (map convergence). Thus if further validated, the approach could be of great value to researchers and teachers as complementary and objective measures of learning.

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VERBKA: AN APPROACH TO BUILDING CAUSAL CONCEPT MAPS BASED ON VERBAL SEMANTICS

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Abstract. Organizations need to find strategies to deal with their challenges. Knowledge Management is a critical resource to the definition of these strategies. In order to do so, organizations use knowledge representation, which in turn is linked to a previous knowledge acquisition process. These processes must be complete and unambiguous. Concept maps are widely used to represent knowledge in organizations, simplifying knowledge storage, retrieval, and use. However, one of the significant gaps in knowledge representation is the comprehension of causal relationships between concepts. Whereas concept maps are able to model causal relationships, this capability is still sparsely explored. This occurs because causal relationships are not usually considered in traditional knowledge representation processes used in the construction of concept maps. To bridge this gap, we present a concept map modeling based on knowledge acquisition through verbal semantics. Results show that this modeling represents causal relationships between concepts, maintaining knowledge's original semantic structure, and allowing knowledge understanding as a whole. We conclude that this approach systematically acquires and represents the knowledge present in causal relationships, and may facilitate knowledge management in organizations and the definition of strategies for problem solving.

1 Introduction

Knowledge Management is essential to deal with problems. It studies how to create, acquire, share, store, and use knowledge in order to develop new ideas, make decisions and solve problems (Machlup, 2014). Knowledge is the result of complex and highly subjective information processing (Davenport & Prusak, 1998), composed by logical and non-logical mental processes such as beliefs, perceptions, experiences, deductions and decisions.

These elements compose what is defined in literature as implicit knowledge (Polanyi, 1962; Nonaka & Takeuchi, 1995). It is difficult to codify this kind of knowledge, because it is incorporated in each individual's actions, perceptions, and ideas. Explicit knowledge, in turn, possesses a formal structure and is codified in language. Thus, it is easier to share and explain than implicit knowledge. In this context, knowledge acquisition, i.e. the identification, capture and modelling of knowledge (Zhou & Li, 2012; Gruber, 2013) can use processes which externalize implicit knowledge through already explicit knowledge.

Organizations need to represent the knowledge they possess in a way that can be easily understood and shared. There are some widely accepted techniques in industry and academia for knowledge representation, such as mind maps (Buzan & Buzan, 2000) and concept maps (Novak, 2010). Concept maps can be used as diagnostic tools for strategic planning, as they allow building consistent scenarios with logical connections. Nonetheless, when causal structures are needed, further research is required. Concept maps might be able to model causal relationships, but this potential is still to be explored (Vasques et al., 2016; Vasques, 2016).

Within this context, we propose a concept map modeling approach based on verbal semantics. We call maps generated through this modeling causal concept maps, since they are able to codify both explicit and implicit causal relationships between concepts. The rest of this paper is organized as follows: Section 2 addresses concept maps; Section 3 presents the main proposition of Verbka. Due to space limitations, a more detailed description of the process can be found in Vasques et al. (2016) and Vasques (2016). Section 4 shows the application of Verbka and the conclusions are presented in Section 5.

2 Background: Concept Maps

Concept maps were created in order to deal with knowledge. In concept maps, concepts are labelled through a reduced number of words, defining a perceived regularity in objects and events (Novak & Cañas, 2008). These concepts are placed inside circles or boxes, connected by labeled arrows. Concepts linked by an arrow create a proposition, representing a logical thinking system (Novak, 2010).

This logical thinking system uses natural language as its base to add meaning to relationships between concepts, thus structuring the map's topic. This is why concept maps are widely used in Knowledge Management to visualize relationships between knowledge components, facilitating new knowledge generation.

To Safayeni, Derbentseva, and Cañas (2005), concept maps are ideal to represent static and hierarchical relationships. Nonetheless, for the representation of functional or dynamic relationships, the same authors propose the use of cyclic concept maps. Cyclic concept maps are not necessarily hierarchical and thus they allow a more dynamic and flexible knowledge modeling (Cañas, Novak, & Reiska, 2012). Within this context, our approach uses this kind of knowledge representation.

3 Verbka

There is a large amount of already explicit knowledge in documents. In order to objectively use this knowledge, it is convenient to use a process based on semantic rules. Within this context, Verbka is a knowledge acquisition process capable of decoding text through semantic information, to later recode this text in the form of a causal concept map (Vasques et al., 2016; Vasques, 2016). Verbka is an acronym for "**Verb**-based **K**nowledge **A**cquisition" and it aims to maintain semantic fidelity from the original text as much as possible, avoiding misinterpretation of represented knowledge while improving reading comprehension. This knowledge acquisition and representation process has its foundations on Linguistic theory (Langacker, 1987, 1991). This process allows the insertion of inferences corresponding to original text's implicit knowledge, and the creation of new knowledge (Novak & Gowin, 1984). Verbka is also independent from a specific domain or knowledge area.

At first, the process needs to fragment the original text until its minimum building linguistic blocks become available. These blocks are concepts that construct propositions. To fragment text into blocks, Verbka is composed by a set of extraction rules, i.e. rules to systematically acquire knowledge from documents. These rules create a concept model composed by causal propositions, defined as sentences structured in the following format: X (Agent) affects Y(Patients).

Each proposition (P) is composed by a verb or phrasal verb, its external complement (subject), and its internal complements (direct object, indirect object, and adverb complements). Therefore, there will always be an agent affecting all complementary concepts that compose a proposition. This flow affects all components through a verbal (verb-based) relationship, which consequently, extends to other semantic relationships marked by prepositions and conjunctions present in the proposition. Each of these concepts form the map's underlying structure. They are placed into rectangles, which in turn, are connected by arrows representing linking phrases.

These propositions are modeled through a causal concept map. This process allows an expansion (Section 4) of traditional concept maps by distinguishing between three types of relationships among concepts, according to the verb used: ***a.*** *agent-patient* relations, where it is necessary to establish the difference between the participant who performs the action (agent) and the participant who receives it (patient); ***b.*** *static relationships*, which are not based on action, i.e. they describe objects' properties or attributes, and ***c.*** *reflexive relationships*, in which the agent's action only affects itself.

In this way, the causal concept maps construction process in Verbka is founded on a semantic approach focused on verbs. It is clear that the traditional concept maps are able to represent knowledge as a dynamic model, in which concepts are constantly under change. However, we are not aware of any work in the literature of Knowledge Engineering where a systematic process towards the construction of the maps is formulated and detailed as proposed in this work and its preceding paper (Vasques et al., 2016; Vasques, 2016).

4 Application and Results

To illustrate how Verbka creates a causal concept map from text, we selected a text fragment from an organizational knowledge management reference (Aarikka-Stenroos & Jaakkola, 2012) shown in Table 1. Verbka follows a set of rules to transform that text into a causal concept map. These rules standardize text, explicit all propositions present in the text, fragment these propositions into concepts and their relationships, and finally create a map following the order in which propositions and relationships were extracted from text.

The causal concept map generated from text using Verbka is shown in Figure 1. All concepts and verbs present in the original text remain in the resulting map. Thus, Verbka does not lose information from original text. In the generated map, all relationships between concepts are shown. It is also possible to capture the author´s chain of thought by following the path from one concept to the other. Thereby, this map reveals knowledge structure schematically.

“Recent research increasingly emphasizes that value emerges from the reciprocal interaction processes between customers and suppliers, and not only through the use of the good or service. At the same time, specialization, knowledge intensiveness and technological complexity are growing in many industries, making the supplier and the customer more dependent on each other's knowledge and resources.”

Table 1: Input text (Aarikka-Stenroos & Jaakkola, 2012).

A causal concept map adds to the cyclic concept map the connection of concepts using a cause-effect relationship. Verbka shows this kind of relationship between concepts, considering the verbal typology connecting the subject and the verbal complements. We differentiate among the distinct types of relationships through colors. Red arrows indicate relationships in which the agent clearly affects the patient through an action (transitive verbs). Blue arrows indicate reflexive relationships, i.e. they affect the same agent who perform them (some transitive verbs of perception, reflexive verbs, and intransitive verbs). Finally, black arrows show connections that inflict no action (verbs of state). It is also possible to detect the most prominent concepts, how they are affected, and how they influence the entire network. They appear in bold in Figure 1.

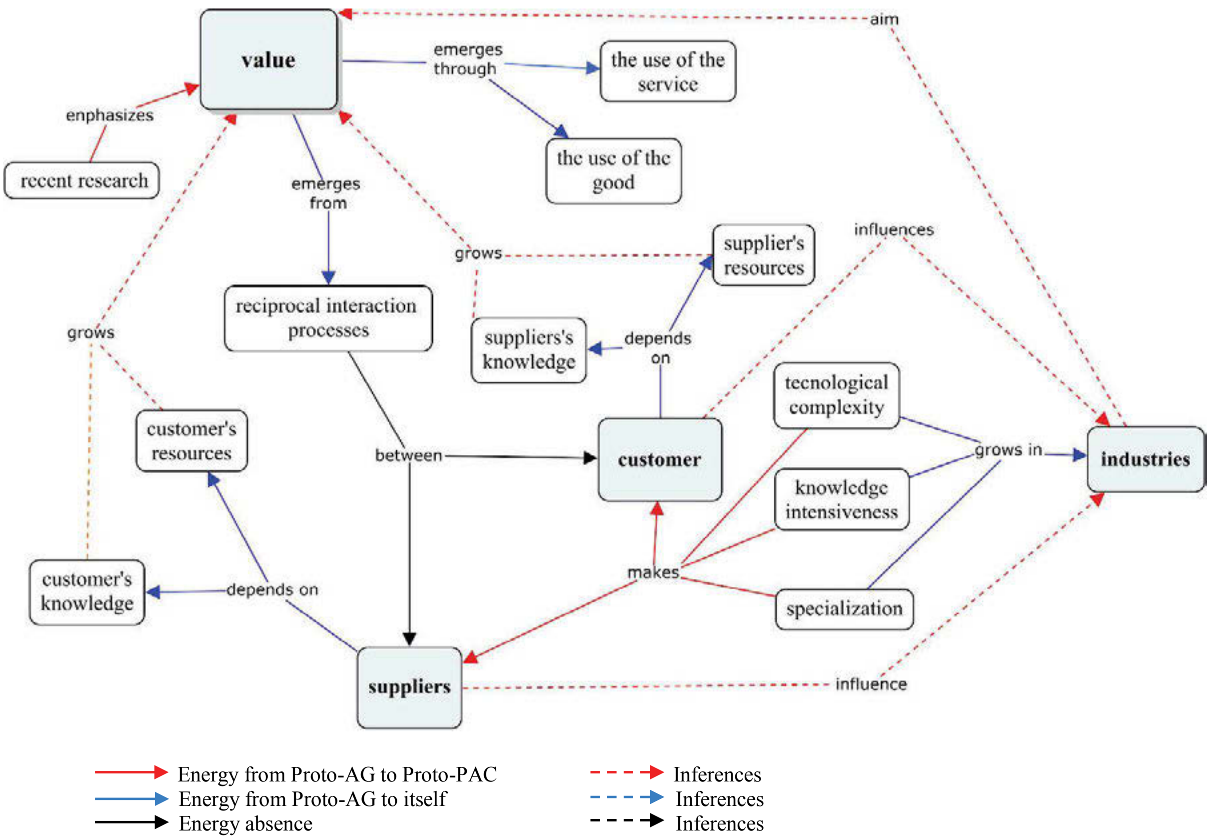

Figure 1. Causal Concept Map.

Verbka may significantly facilitate the inference of implicit connections (due to the map’s layout/structure), i.e. connections that were not present in the original text (but instead derived from text comprehension or from context) by detecting missing connections between concepts. Therefore, it is possible to more easily explicit implicit knowledge and to create new knowledge, adding them up to existing knowledge. This is called meaningful learning (Ausubel, 2012). As an example, new connections are shown in Figure 1 as dashed lines.

This type of representation is able to reveal the structure of knowledge, which is immerse in a network composed of different propositions related to the same context. Therefore, this representation allows a more analytical reading of the system that goes beyond the bare reading of the propositions themselves.

5 Conclusions

Knowledge is a dynamic system under constant transformation and needs to be acquired, modeled and represented as such. Mapping based on actions allows the reader to change the way he or she regards and analyzes a problem because it allows a general view and comprehension of that problem, showing not only isolated concepts and actions, but also the relationships between them. Verbka is a flexible process that can be used in different text typologies. Its application showed that it is able to preserve the knowledge semantics in texts written in natural language, allowing their modeling in causal concept maps.

This work's contributions are related to the fact that Verbka aims not only to extract or model knowledge, but also to add a qualitative (semantic) and systematic approach to the acquired and represented knowledge. This reduces the empirical work (i.e. guesswork) in knowledge acquisition and modeling. By applying Verbka, it was possible to realize the versatility that concept maps have in representing different types of knowledge, including procedural and causal knowledge, creating the base for a more dynamic knowledge representation. In conclusion, this work presented a new way to build, use and interpret concept maps based on verbal semantic relationships. The capability of representing semantic knowledge is a further step in supporting organizations to more efficiently deal with knowledge and problem solving. Future work includes automatization of the process.

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WORLD CAFÉ CMAPS PARA LA ELICITACIÓN Y TRANSFERENCIA DE CONOCIMIENTO ENTRE DOCENTES UNIVERSITARIOS

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Resumen. Esta investigación se enmarca en estudios relacionados con la captación y elicitación de conocimiento experto entre docentes universitarios. Concretamente el trabajo que se presenta se incluye dentro del diseño de un procedimiento como modelo de captación y representación de conocimiento docente con experiencia en el uso de las TIC (Lizana, 2012), para poder ser integrado posteriormente en un Entorno Avanzado de Formación para la transferencia de conocimiento experto. Se presenta el procedimiento y resultado de este proyecto que tiene como finalidad observar y analizar la gestión y transferencia de conocimiento entre docentes de los estudios de Grado de Fisioterapia de la Universidad de las Islas Baleares (UIB). Se ha utilizado un procedimiento de captura y representación del conocimiento individual del docente para posteriormente en una sesión de World Café Cmap (WCC) se generar y transferir el conocimiento tecnológico, pedagógico y disciplinar, en relación al uso docente de las técnicas básicas de fisioterapia en sus materias.

1 Introducción

Tras el gran debate que ha surgido sobre las Tecnologías de la Información y la Comunicación (TIC) a lo largo del tiempo, así como de la Sociedad de la Información y la introducción de las TIC en cualquier nivel del ámbito educativo, no se han cuestionado las diferentes oportunidades de ser introducidas en la docencia universitaria.

Además, la implantación de los planes de estudio en el EEES no ha hecho más que destacar todavía más la necesidad del uso de dichas tecnologías.

Las universidades poco a poco se han ido adecuando a las nuevas necesidades, desarrollando nuevas herramientas y aplicaciones, espacios de educación que fueran diferentes de lo tradicional.

Sin embargo implementar el cambio en el campo educativo presenta grandes desafíos, pues exige la redefinición de los componentes que conforman el proceso educativo: actores (estudiante, profesor, entorno) y de los procesos (organización, planificación y evaluación).

Así surge el concepto de TPACK (Technological, Pedagogical And Content Knowledge) en el 1986 con el objetivo de identificar la naturaleza de los conocimientos requeridos para integrar las TIC en la docencia (Shulman, 1986).

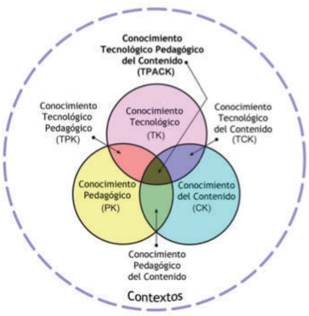

Figura 1. Modelo TPACK Extraído de http://www.tpack.org

Según el modelo TPACK (Mishra & Koehler, 2006) se requieren tres tipos de conocimientos: conocimiento del contenido (disciplinar), conocimiento tecnológico y conocimiento pedagógico, que al entrelazarse dan lugar a siete tipos de conocimientos, tal como se muestra en la figura superior.

En nuestro caso, la investigación pretende observar y analizar la gestión y transferencia de conocimiento entre docentes de los estudios de grado de fisioterapia de la Universidad de las Islas Baleares (UIB) mediante la metodología de trabajo de World Café Cmap (WCC).

2 World Café Cmap

Después de trabajar con los docentes mediante el procedimiento de captura y representación del conocimiento TPACK (Lizana, 2012), se decidió utilizar la metodología del World Café Cmap para, mediante un grupo focal extraer el conocimiento colaborativo, capturado previamente de forma individual.

Según Trujillo (2012) esta metodología se usa en forma de taller. En este taller mediante las conversaciones sobre un tema específico se consigue expresar el conocimiento de una forma más informal, lo que consigue elicitar ese tipo de conocimiento experto que no se expresa en otros ámbitos o cuando se realizan entrevistas específicas. Así, denominan a estas conversaciones TallerCafé donde se registran los mapas conceptuales realizados del debate, llevado a cabo en esas conversaciones.

De esta forma, utilizamos este tipo de metodología y además la forma de extraer, elicitar y representar el conocimiento experto según como lo han realizado previamente Cañas y Novak (2006).

3 Fases de la Investigación

La experiencia se ha desarrollado en diferentes fases, siguiendo la metodología utilizada para la captura y representación de conocimiento TPACK (Lizana, 2012). Las fases del proceso se pueden definir de la siguiente manera:

- Primera fase: Familiarización de los docentes con la experiencia a llevar a cabo. En esta fase se les explicó a los docentes el proyecto, se seleccionaron los posibles temas a trabajar que sirvieran de incentivos y que fueran de interés para el investigador. Además, se les presentó el modelo TPACK, modelo del que parte la investigación, como más adecuado para conocer cuál es el grado de conocimiento tecnológico, pedagógico y del contenido de los docentes participantes.
- Segunda fase: Recogida de información para abordar la temática. En esta fase se recolectaron las guías docentes para analizar cómo se trabajaban en cada una de las asignaturas las técnicas básicas de fisioterapia y las competencias.
- Tercera fase: Diseño del entorno de trabajo. Se ha utilizado la herramienta CmapTools (Cañas et al., 2004) como herramienta principal para construir el entorno de trabajo colaborativo para los docentes.
- Cuarta fase: Diseño de la entrevista. Partiendo de las entrevistas realizadas (Lizana, 2012) para la captura y representación del conocimiento experto de los docentes, se diseñaron las entrevistas para cada uno de los docentes de las materias participantes.
- Quinta fase: Entrevistas individuales. Se realizaron entrevistas semiestructuradas en los despachos de cada uno de los docentes. Se utilizó la metodología de mapeo durante la entrevista. Se iba mapeando lo que el docente respondía en cada una de las preguntas. Estas entrevistas fueron registradas con una grabadora, para la posterior corroboración del material obtenido, así como para la maquetación final de los mapas. A continuación, se puede visualizar un mapa generado tras la información capturada.

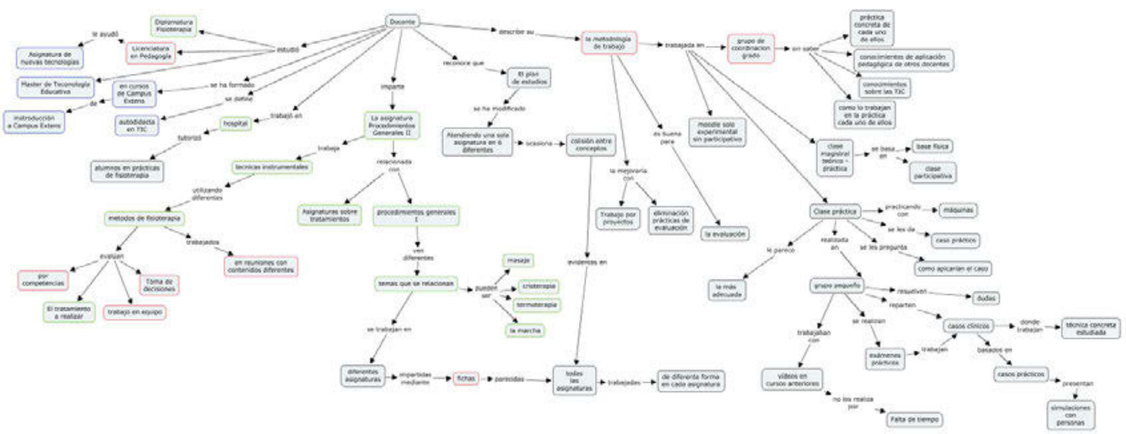

Figura 2. Representación conocimiento elicitado de un docente en la entrevista inicial individual.

- Sexta fase: Transcripción de las entrevistas y maquetación de los mapas. Se realizó una profunda transcripción del contenido de las entrevistas registradas con la grabadora y de cada uno de los mapas, adecuándose al modelo utilizado en Lizana (2012) para comprobar que se habían explicitado en cada una de las entrevistas los tres conocimientos del modelo TPACK, conocimiento tecnológico, pedagógico y del contenido. No obstante, cada uno de los mapas representan en diferentes colores los tres conocimientos extraídos a cada docente.

- Séptima fase: Planificación del grupo focal con los docentes. Se utilizó la técnica de grupo focal para realizarse a modo de sesión informal, en la que los docentes pudieran hablar libremente en una sesión conjunta como si se tratase de una reunión del grupo.

Tras el análisis del conocimiento representado en los mapas individuales, toda la sesión consistía en la realización de preguntas relacionadas con el conocimiento extraído, y en relación a la pregunta disparadora que esta fue "¿Cómo trabajan las técnicas básicas de fisioterapia en cada asignatura y cómo se relacionan en las otras asignaturas?".

La sesión se realizó en dos horas y consistía en:

- Presentación visual del entorno en el que se va a trabajar y el mapa que se va a construir con el conocimiento generado en la sesión de trabajo (de Benito, Lizana, Salinas, Urbina, 2014).
- Presentación de los objetivos de la sesión.
- Presentación sobre la mesa de los 5 mapas generados de sus cinco entrevistas individuales. Esto sirvió para empezar a trabajar en la sesión y que vieran las conexiones y diferencias entre sus mapas.
- Siete minutos para debatir sobre cada pregunta que realizaba en investigador (relacionada con el conocimiento extraído). Se realizaron un total de 9 preguntas. El conocimiento extraído en estas preguntas era presentado in situ en un mapa conceptual con la utilización del proyector del aula.
  Las preguntas estaban relacionadas con los siguientes ítems:
- Importancia entre la teoría y la práctica en la asignatura.
- Relación de los conceptos entre las asignaturas.
- -Cómo se trabaja el proceso (valoración-tratamiento-herramienta).
- Cómo se trabajan los diferentes casos clínicos.
- Organización de los alumnos.
- Tipos de simulaciones utilizadas.
- Técnicas de evaluación.
- Cómo mejorar la evaluación continua.
- Porque SI/NO utilizar las TIC en la asignatura?

-

Imagen 1. Fotografía de la sesión de WCC con docentes del Grado de Fisioterapia de la UIB.

4 Resultados

Todos los docentes reconocen no tener tiempo para dedicar a la realización de nuevas actividades con el uso de las tecnologías, además el aumento de docentes asociados que no tienen mucho tiempo para este tipo de actividades.

La mayoría de los docentes se han formado de forma autónoma en el uso de las TIC y demás campos de su disciplina, en lo que se refiere a la formación continua.

La realización de prácticas novedosas con el uso de las TIC las han pensado e intentado llevar a cabo, pero por tiempo y coste no lo pueden realizar.

Prácticamente todas las asignaturas tienen un mismo esquema, en el que se trabaja una parte teórica en gran grupo y una parte práctica en mediano y pequeño grupo. Lo que sí varía es la forma de aplicar las prácticas con los alumnos.

En la clase práctica se les proporcionan casos que después tendrán que trabajar y simular en clase los alumnos, pero cada docente utiliza estos casos clínicos para evaluarlos de forma distinta. Unos realizan un debate en clase sobre las simulaciones expuestas, otros evalúan directamente a los dos ó tres alumnos que realicen la simulación. Hay otros que directamente evalúan mediante los exámenes escritos tipo test.

Para la realización de las prácticas, si la asignatura lo permite, se utilizan métodos alternativos y mucho más enriquecedores para los alumnos, como el dibujo sobre el propio cuerpo, de esta forma un docente explica que puede mejorar su comprensión y posterior aprendizaje y aprobado del alumno.

Algunos docentes trabajan los mismos conceptos o casos clínicos sin saber qué han trabajado en otras asignaturas, de esta forma pueden repetir conocimientos e incluso casos con los alumnos. En asignaturas de primer y segundo semestre no suele pasar, pero si se dan en el mismo semestre sí.

5 Conclusiones

Mediante la realización de las entrevistas iniciales a los docentes, se pudieron extraer los siguientes datos; conocer cuál había sido su trayectoria profesional antes de llegar a ser docentes y, por tanto, que formación o experiencias, habían tenido antes. También se pudo conocer la forma en que cada uno de los docentes lleva a cabo su asignatura y cuáles son las metodologías que utilizan, así como la evaluación y competencias a evaluar de las mismas.

A través de la sesión grupal de WCC entre todos los docentes y la investigadora, así como también, mediante la creación grupal del mapa conceptual con el CmapTools, todos ellos pudieron conocer un poco más la relación con cada una de las otras asignaturas. Observando sobre todo que siendo unas asignaturas muy relacionadas se imparten de forma muy diferente. Algunos docentes también llegaron a la conclusión de que pensaban que algunas asignaturas no estaban nada relacionadas y, a través de esta experiencia, vieron que estaban equivocados y que tenía mucho que ver una con otra.

Finalmente, a través de las últimas entrevistas realizadas a cada uno de los docentes, la mayoría calificaba la experiencia de muy organizada, sencilla, sin una necesidad de carga ni dedicación de tiempo muy elevada y con unos resultados mejores y más satisfactorios que si se llevara una a cabo una reunión sobre el mismo tema. Algunos de ellos, destacaron que hubiera sido muy interesante haber realizado una segunda reunión después de haber realizado el mapa conjuntamente.

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APPLICATION OF CONCEPTUAL MAPPING TO CLIMATE CHANGE EDUCATION: MOVING TOWARD THE 'ADJACENT POSSIBLE'

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Abstract. Three forces converge to create a time of transformation: global attention to climate change; the development of the Next Generation Science Standards; and increased emphasis on the significance of metacognition. Johnson's work provides understanding of the social context that supports innovation, particularly the concept of the 'adjacent possible.' Two new applications of conceptual mapping are submitted: a concept map of climate change/ education linked to multiple resources and a strand map of weather/climate standards. Conference attendees are asked to offer feedback on these maps and to collaboratively construct a metacognition toolbox to address complex socio-environmental challenges.

1 Introduction: Changes Call for Innovation

Three forces converge to create a time of transformation: global attention to climate change; the development of the Next Generation Science Standards; and increased emphasis on the significance of metacognition. "Climate change is the greatest challenge of our time… In short, it threatens our planet, our only home," asserted Thomas F. Stocker, the 2013 IPCC co-chair (Gilis, 2013). The concept of climate change has found a solid fit in the Next Generation Science Standards currently being adopted/adapted/or rejected at the state level in the United States (NGSS Lead States, 2013). The NGSS include strand maps with learning progressions that demonstrate how the key concepts of science may develop in students' minds over the K-12 grade span. Strand maps are similar to concept maps in showing cohesive connections among concepts. They differ, however, in that they are at a more general level and are designed to represent a population's development of complex concepts over years rather than an individual's thinking of specific concepts with a variety of propositional linkages at a particular point in time. In a recent report in *Science*, researchers found that, "whereas most U.S. science teachers include climate science in their courses, their insufficient grasp of the science may hinder effective teaching." (Plutzer et al, 2016) Clearly, the implementation of high quality climate change education in the classroom is lacking. Meanwhile, a call for increased emphasis on metacognitive abilities has been sounded by the revised Bloom's taxonomy (Krathwohl, 2002) upon which many of the cognitive objectives of classroom work are built; the American Association for the Advancement of Science (National Research Council, 2000 and 2005); and the National Science Teachers Association (Bybee, 2002).

In response to these developments, Johnson offers a perspective on the origins of innovation in his book *Where good ideas come from: the natural history of innovation* (Johnson, 2010). He focuses on the 'adjacent possible,' a term he credits to chemist Stuart Kauffman, but applied by him to the conceptual world in addition to the physical world. Innovation often emerges as the next "good idea" built on a new vision of available building blocks. "We take the ideas we've inherited or that we've stumbled across, and we jigger them together into some new shape." He sees innovation as the work of both the individual and the collective.

2 Individual 'Adjacent Possible'

"All of us live inside our own private versions of the adjacent possible. In our work lives, in our creative pursuits, in the organizations that employ us, in the communities we inhabit—in all these different environments, we are surrounded by potential new configurations, new ways of breaking out of our standard routines." (Johnson, 2010) In the past, this researcher has applied conceptual mapping to science education research, teaching, learning, and evaluation of standards (Gorman & Heinze-Fry, 2014). Provided below are links to two new applications, the individual 'adjacent possible':

- a weather/ climate change strand map:
  - http://cmapspublic2.ihmc.us/rid=1PY4HNMV1-21VP2Y3-5K29/StrandMap-PreK-12-WC.cmap.cmap
- a concept map of climate change/ education linked to digital resources: http://cmapspublic2.ihmc.us/rid=1Q1B9HWXL-4CKNSV-3XJG/Climate%20Change%20Bite-Sized.cmap
  - Please offer your feedback about the utility of these innovations and how they might be improved.

3 Collaborative 'Adjacent Possible'

Johnson (2010) asserts that "innovative environments ... expose a wide and diverse sample of spare parts—mechanical or conceptual—and they encourage novel ways of recombining those parts... The trick is to get more parts on the table." The urgency of the changes described above compel researchers to develop tools to think more deeply, clearly and transparently; to solve more complex problems; and to make more complex decisions. Many researchers have applied concept maps and Vee heuristics to science education, sustainable development and other challenges (Novak & Gowin, 1984; Novak, 1998; Åhlberg, 2004; Iuli & Helldén, 2004; Vanhear & Pace, 2008; Proctor & Bernstein, 2012). A preliminary metacognition toolbox that demonstrates these tools and a few others already "on the table" can be found at: http://cmapspublic2.ihmc.us/rid=1Q3X92V22-1PP4FDW-DW81/Metacognition%20and%20Sustainability%20%2526%20Resilience.cmap With the draft metacognition toolbox as a catalyst, researchers are asked the following questions to move the community to a collaborative 'adjacent possible.':

1. In what specific ways could concept mapping, vee heuristics, and additional metacognitive tools be used
    1. to address climate change and other complex problems?
2. How can a metacognition toolbox be structured to facilitate substantive responses to complex problems?

This international conference offers an innovative environment from which such a toolbox can emerge.

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APRENDIZAJE COOPERATIVO CON MAPAS CONCEPTUALES

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1 Introducción

Se ha realizado un seminario abierto en el que los estudiantes tenían que presentar un mapa conceptual sobre el proceso enfermero a pacientes con problemas endocrinos, contenido extraído del programa de la asignatura.

Desde el primer día de docencia se explicó a los estudiantes la innovación facilitándoles, a través de la plataforma e-learning, una guía con la descripción de la innovación, así como la documentación de lectura y una bibliografía mínima para dar respuesta a la materia de estudio. También se les facilitó la herramienta CmapTools (http://cmap.ihmc.us/download/), para que se iniciaran en la construcción del mapa conceptual a partir de un software especializado. Asimismo, se asignó a cada grupo el tema a tratar.

El objetivo de este trabajo ha sido implementar una metodología de aprendizaje cooperativo a partir de la construcción de un mapa conceptual del tema tratado.

2 Metodología

- La actividad se realizó en horas no presenciales.
- Organización de los estudiantes en grupos de trabajo.
- Elaboración de un mapa conceptual con la síntesis del trabajo realizado

3 Resultados

El día planificado para el seminario cada grupo de estudiantes explicó el mapa conceptual del tema asignado. La evaluación del mismo se ha llevado a cabo a partir de una rúbrica diseñada a tal fin, y de un cuestionario de conocimientos en la plataforma e-learning, obteniéndose los siguientes resultados (gráfico 1):

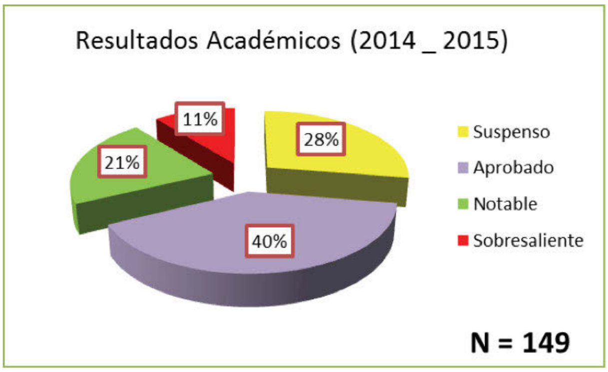

Gráfico 1. Resultados de la evaluación del Mapa conceptual.

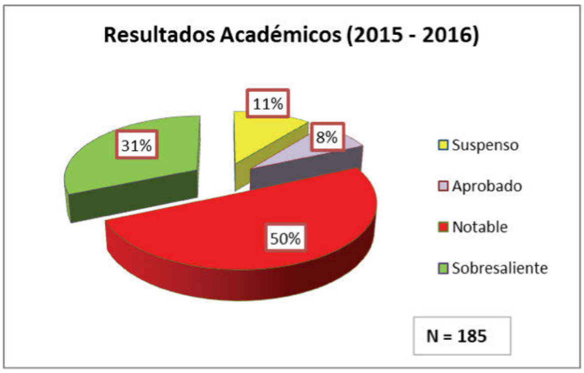

Gráfico 2. Resultados de la evaluación con docencia convencional.

Comparando los resultados con los obtenidos el curso 2014 – 2015, en el que este módulo se impartió con docencia convencional en aula (gráfico 2), se observa mejor puntuación en la adquisición de conocimientos con la experiencia innovadora, puesta de manifiesto por un progreso de todas las categorías académicas.

Asimismo, se recogió la opinión de los estudiantes a partir de una escala Likert, cuyos resultados se corresponden con los gráficos 3 y 4. Solo respondieron 84 estudiantes de los 185 matriculados y que habían participado en la experiencia.

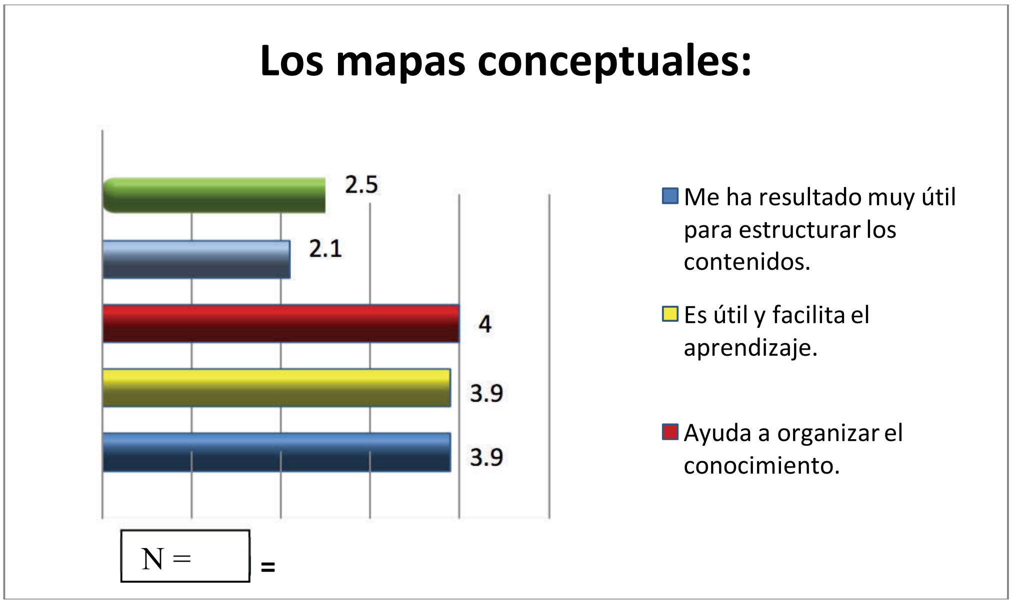

Gráfico 3. Respuestas de los estudiantes a un cuestionario.

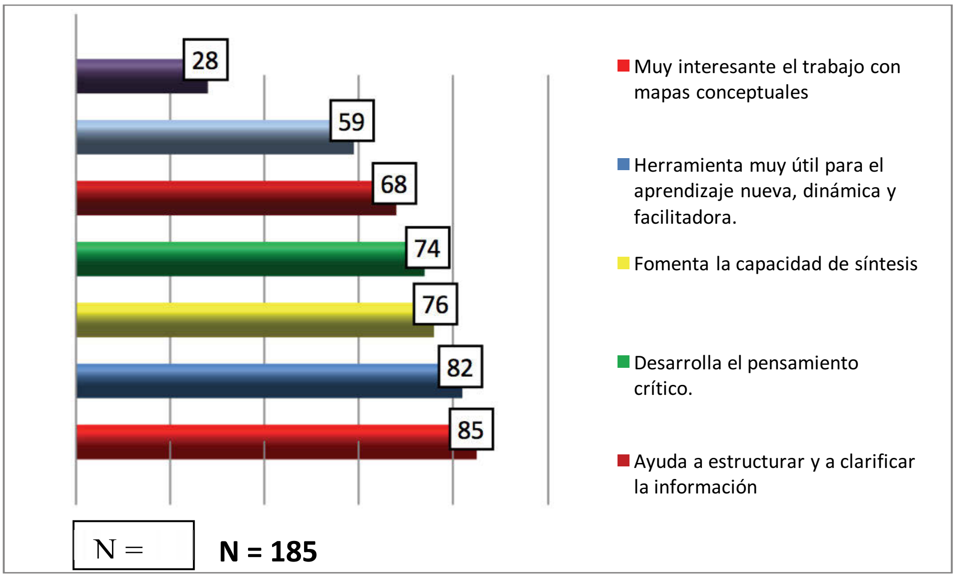

Gráfico 4. Opinión abierta de los estudiantes.

4 Conclusiones

Según los resultados académicos, pensamos que, con actividades de este tipo, se pueden abordar eficazmente contenidos. En este marco, los mapas conceptuales constituyen un método que optimiza el aprendizaje del alumnado universitario porque mejora la comprensión y el conocimiento de los contenidos, facilita la discriminación de los elementos fundamentales, al mismo tiempo que permite determinar el tipo de aprendizaje (significativo o memorístico) que el estudiante adquiere a partir del desarrollo de un tema.

AUTHENTIC PROBLEM SOLVING AND CONCEPT MAPPING

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1 Introduction

Authentic problem solving is a form of situated learning, learning in a situated context. Learning is effective when it occurs in meaningful everyday activities (Lave, 1988). In such situated learning contexts individuals apply knowledge practically and routinely to solve everyday problems. In formal economic learning in schools, however, this is often not the case. In school, students learn more abstract knowledge (Brown, Collins, & Duguid, 1989).

The answer to everyday economic problems depends heavily on the context in which the problem occurs. Retrieving the abstract knowledge, relevant to the concrete problem, is necessary (Bransford, Brown, & Cocking, 1999). Thus, connecting concepts and contexts demands the ability to link abstract economic concepts with concrete phenomena in practical contexts (Kneppers, Elshout-Mohr, Van Hout-Wolters, & Van Boxtel, 2007).

2 The Experiment

In the experiment we used concept mapping to improve this ability. The task concerned a complex social problem related to an economic topic:

"Kok's quarter" refers to the raising of the price of petrol by a supplementary duty of 25 cents (in Dutch guilders) per liter, a raise that was carried out by the Dutch government under prime-minister Kok to discourage motorized traffic. The tasks for the students was to discuss the possible economic effects of returning this supplementary duty to the costumers. They had to make a concept map in which they combined the conCepts (C) and the conText (T).

Figure 1 represents a concept map made by a student of the pre-final year of pre-university education in The Netherlands.

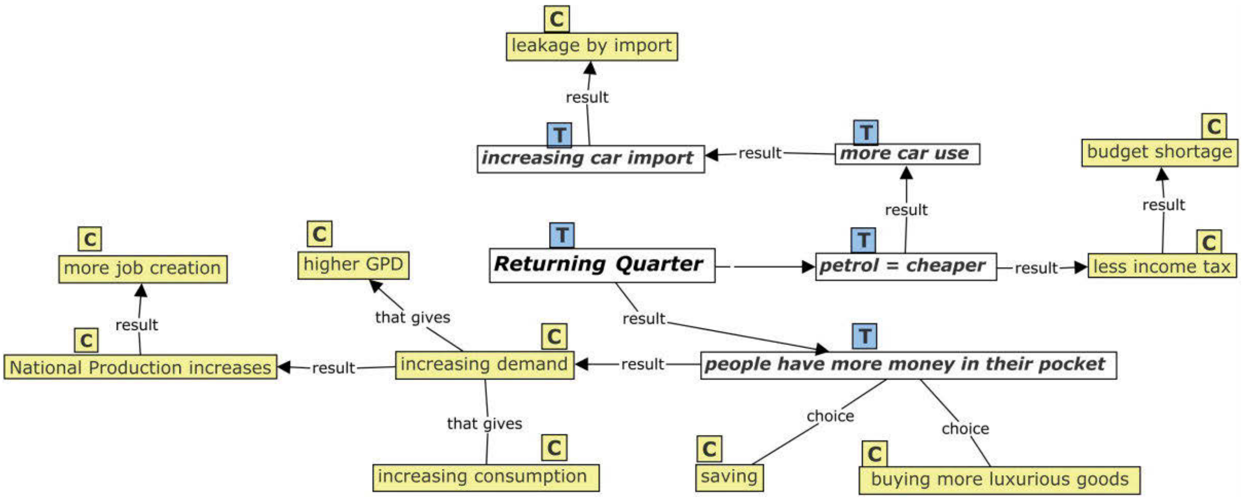

Figure 1. Concept map showing concept and context relations

In the concept map you see related to the original problem 'returning the quarter' context labels T, e.g. petrol = cheaper → more car use → increasing car import linked to the concept label leakage by import. This shows situated knowledge. However, most of the other links were abstract economic concepts links.

This was the case in most of the concept maps made by the students. Students were falling back to their general economic knowledge. In their economic lessons it is expected from them. It is also possible that they were not able to put themselves in the position given the context. But they recognized the problem and were very interested. What is needed to connect context with concepts? From the context view they have to recognize the underlying economic knowledge. It can be seen as a form of transfer. But the farther the transfer the more it requires deeply understood domain knowledge (Perkins & Salomon, 1989). Mayer (2002), Krathwohl (2002), and Anderson and Krathwohl (2001) mention in their improved taxonomy of Bloom (1968) that deep understanding can also be developed by solving context problems. The students in this experiment never before learned economic concepts by studying a context. But the context in this experiment brought them to discussions that in some cases was leading to construction or reconstruction of knowledge. In figure 2 shows an example of a discussion where students switch from context to concept and vice versa and come to construction.

Kelly: people get the quarter back.
Quido; yes and they are going to buy a new car
Kelly: but, you can say they are consuming more
Quido: they can also save the money
Kelly: but I think that with returning the quarter.. than you have less income
Quido; you mean National Income, there is more National Income
Kelly: But there is less National Income, I think?
Quido: I think more
Kelly: If consumers pay less for their fuel then there is less National Income.
Quido: Oh, you are wright!

Figure 2. An example of a discussion between Kelly and Quido.

3 Discussion

Some questions arise seeing the concept map.

- Is combining context and concepts in a concept map a useful contribution to support students in retrieving more situated knowledge, appropriate to the problem?
- Is the problem task used here adequately? Is the context, although an authentic problem, perhaps too general to provoke more relations between context and concepts?
- Was, for example, the need to make more relations T and C if it had been asked for the effects of the returning for a specific group for example a family with young children or for an elderly couple with specified conditions?
- What are, in general, the conditions for the task?

We like to discuss these questions!

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CONCEPT MAPS IN CULTURAL EDUCATION. A CASE STUDY ON DANCE THEATER

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Abstract. The paper presents an innovative experience on recording the conceptual representations of primary school students using concept maps, in order to explore their construction about the concepts "human body" and "dance" before they take part in a cultural project about dance theater. The outcomes of the process gave the opportunity to design and implement a more appropriate educational approach.

1 Introduction

Concept maps are based on the theory of constructivism. In a constructivist frame a person develops cognitive models that serve future thinking or acting. The process of knowledge construction depends on our conceptual representations. Effective learning means structuring new knowledge models using, expanding, revising or erasing the pre – existed representations. Thus, the study of representations is a crucial matter in order to design appropriate educational environments.

Concept maps are able to present a student's knowledge structure before teaching. The methodological approach proposed in this paper was applied in real class conditions before the implementation of a cultural project about dance theater, in which participated 22 children of Greek primary schools from 9 to 11 years old.

2 Theoretical Framework

Contemporary psychological approaches of learning and didactics create a new, common base for the design and the materialization of various subjects. Nowadays the aspect that learning procedure is not possible to be materialized if it doesn't take under consideration the conceptual representations of students and the process of knowledge construction is becoming more and more acceptable. Thus, learning is not a knowledge collecting process, is not being acquired or transferred. On the contrary, it is possible only with the conceptual contribution of the person that learns and it is taking place when the exploration of the student reveals inconsistencies between current representations and experience. In that case, student tends to change his/her conceptual model not necessarily in order to replace it by the objectively right but by the viable (Viennot, 1979). Therefore, starting point of learning is what a person knows or ignores before teaching. Often traditional teaching slightly effects the conceptual representations of a student not only after a course but even after adult age (Ravanis, 2003), because of the indifference of conceptual representation during teaching. It is clear that an educational approach based on constructivism has to study the conceptual representations of students.

Concept maps are a cognitive tool variously used in learning process. Were first presented by Novak and Gowin (Novak & Gowin, 1984, Novak, 1990, Novak, 1998) and were based on the theories of Ausubel (Ausubel, 1968). They are a popular way to represent knowledge (Novak, 1990, Jonassen et al., 1994, Fisher, 1990) and to reveal the representations of the person that takes part in learning process (Fisher, 1990, Star et al., 1990). A concept map is consisted by concepts and links. Links represent the relations among concepts and can be labelled or not orientated or not. Linked concepts form propositions.

3 Methodology and Outcomes

Given that the subject of the dance theater isn't included in the official curriculum of Greek primary schools we had no experience on a proper didactical approach. In order to design a curriculum that could really serve the needs of our students we used concept maps. Our goal was to monitor and study their conceptual representations about dance. Thus, students constructed concept maps with two given concepts "human body" and "dance" in eleven pairs, before teaching. The concept maps were qualitatively evaluated in order to reveal their conceptual representations. The outcomes highlighted significant misconceptions. The majority of the participants, ten out of eleven pairs, on one hand doesn't consider dance as an art and on the other hand combines modern dance to sports than to dance. Only one pair of students defines ballet as an art. The same pair doesn't consider modern dance as an art. Also ten pairs don't combine dance with expression of feelings, even if they combine human body with the expression of feelings.

Concluding, it was obvious that before the implementation of the dance theater project should be designed special activities which would help children to construct new knowledge about the modern and classic dance as forms of art which provide people means of expression, through human body.

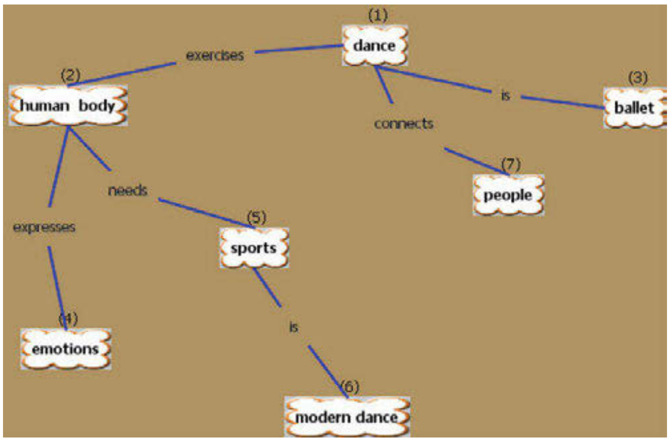

Figure 1. Translated concept map from Greek, constructed from one of the 11 pairs of the case study.

4 Conclusions-Future Perspectives

We believe that the case study presented above succeeds in highlighting the use of concept maps as a sensitive method of monitoring conceptual representations and designing a curriculum. Also the implementation phase of the project which followed, highlighted that the designed activities were very suitable for children' s educational needs and created a new common base of understanding for the class, in order to participate in the innovative project of dance theater in school.

A future perspective should be the monitoring of a wider sample of children, in order to study in a more quantitative way the conceptual representations of children of primary schools in Greece about dance and body. Additionally, a comparative analysis of concept maps constructed by primary students of other countries, would be able to reveal significant information about the possible influence of cultural background on students' representations.

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CONSTRUYENDO MI PROYECTO DE VIDA MEDIANTE ITINERARIOS DE APRENDIZAJE BASADOS EN MAPAS CONCEPTUALES

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Abstract. En la institución educativa Gabriel García Márquez se viene implementando una propuesta de uso de itinerarios de aprendizaje basados en mapas conceptuales, que potencian el desarrollo de las competencias del diseño curricular, siendo este el caso No. 4 de aplicación sobre estudios y trabajo de investigación de la tesis doctoral de Olga Lucía Agudelo., donde se implementa inicialmente y como prueba piloto con estudiantes de grado 9° y posteriormente se vinculan a los estudiantes del grado 8°, nivel de educación básica del ciclo secundaria. Los itinerarios de aprendizaje con un diseño basado en mapas conceptuales proporcionan flexibilidad para que el alumno ejerza cierta autonomía en su proceso de aprendizaje, resuelva situaciones de la realidad mediante la construcción y creación de nuevos esquemas y formas organizativas del aprendizaje.

1 Introducción

Los itinerarios de aprendizaje basados en Mapas conceptuales en la Construcción del Proyecto de vida, han sido una guía para los estudiantes sobre cómo estudiar o aprender un tema en particular. El itinerario ofrece alternativas para que el estudiante elija la forma de proceder a través de las actividades previstas. Un itinerario no describe el tema, recomienda cómo el tema puede ser estudiado, por lo que es diferente de un mapa descriptivo tradicional. En este contexto, los mapas conceptuales pueden ser utilizados para generar procesos de aprendizaje autorganizado, procesos no líneales, orientados al desarrollo de distintas competencias. Orientada por la pregunta ¿Cómo los mapas conceptuales pueden apoyar el desarrollo de competencias en itinerarios de aprendizaje flexibles?, donde se describe una experiencia piloto en una institución de educación básica, buscando determinar características clave del diseño instruccional.

2 Diseño de la Propuesta

Se diseñó con las docentes un itinerario orientado a las áreas de Tecnología e informática y Emprendimiento: "Construir mi proyecto de vida", para estudiantes de los grados 8° y 9°, con el cual se busca utilizar herramientas informáticas y aplicar el ciclo de gestión de la información. Ver Diseño en el siguiente enlace:
http://mapas.futurodigital.org:8080/rid=1N8FL60HK-K0W9SD-MP/Proyecto%20de%20vida.cmap

Dentro del área de Tecnología e informática se trabaja en torno a la competencia (Ministerio de Educación Nacional, 2008): Apropiación y uso de la tecnología, centrado en los siguientes estándares: Utilizar eficientemente la tecnología en el aprendizaje de otras disciplinas (artes, educación física, matemáticas, ciencias). Utilizar responsable y autónomamente las Tecnologías de la Información y la Comunicación (TIC) para aprender, investigar y comunicarme con otros en el mundo. Desde el área de emprendimiento se trabaja en torno a la construcción de un proyecto de vida, con guías incluidas en el itinerario y los objetos de aprendizaje son aportes de las docentes que tienen experiencia en la orientación de esta área. Además, se retoman elementos de áreas como español y ética.

2.1 Implementación de la propuesta

Descripción del ecosistema de aprendizaje que rodeó la implementación.

2.1.1 Contenidos: Centrado en elementos del ciclo de gestión de la información, el itinerario orienta el trabajo en torno a herramientas ofimáticas así: Buscar y validar información, requiere procesos como aplicar técnicas de búsqueda en internet, que luego se evidencian en la búsqueda de información para el proyecto de vida. De esta misma manera se trabajan los demás estándares de competencias.

2.1.2 Metodología: Teniendo en cuenta que el proceso se dirige hacia la construcción del proyecto de vida, el trabajo se hace generalmente de manera individual y da total flexibilidad al estudiante para avanzar a su ritmo, incluso en tiempo extra ya que tienen acceso a la institución en tiempo extracurricular para trabajar en los equipos de cómputo. Se cuenta además dentro del itinerario con apoyo en línea y otros elementos como cuadros de autocontrol que surgieron de la primera experiencia con este itinerario.

2.1.3 Rol del docente: La situación de las docentes de este caso es especial, pues hicieron parte de la primera experiencia con itinerarios (Agudelo O. L., 2013), por lo cual ya habían vivido la implementación de esta metodología. El itinerario aplicado ya está en una tercera versión y son ellas mismas las que han ido reorganizándolo. Las guías y objetos de aprendizaje y otros recursos como la zona de recreo son aportes realizados por ellas a través de su propia experiencia.

2.1.4 Rol del estudiante: Los estudiantes aprovechan la flexibilidad que les brinda este ambiente de aprendizaje asumiendo el control de su propio aprendizaje dentro del itinerario. La colaboración y asesoría entre pares es más evidente y también la participación en espacios virtuales.

2.1.5 Recursos: Igual que en el caso anterior, como recursos físicos se dispuso de un aula de computadores y un video proyector para apoyar el trabajo en el aula, momentos de asesoría grupal y socializaciones. El trabajo dentro del itinerario estuvo enriquecido por objetos de aprendizaje conformados por guías, herramientas ofimáticas, herramientas en línea, espacios virtuales, videos, documentos y fichas, elaborados o seleccionados por las docentes quienes tuvieron en cuenta la evaluación de las implementaciones anteriores**.** Ver Link de algunas Guías:

2.1.6 Interacciones: Las interacciones en el aula estuvieron marcadas por los procesos de asesoría entre los compañeros y algunas veces con su profesora. Se utilizaron mucho los espacios virtuales para la asesoría con las docentes y para la coevaluación de los trabajos de los demás estudiantes.

3 Datos

3.1 Participantes: Ver los participantes en el siguiente enlace:
https://drive.google.com/file/d/0B1MKbDd8DF0PdDhYOVh4VmJFMmc/view?usp=sharing

3.2 Evaluación: La evidencia de las competencias adquiridas se centró en la construcción del proyecto de vida, es decir: Encontrar información sobre el proyecto de vida, definir el perfil profesional, consolidar su proyecto de vida y socializar la construcción del proyecto de vida.

Durante el desarrollo del itinerario se realizó un proceso de coevaluación y de autoevaluación, este último a través del cuadro de autocontrol (Ver Cuadro en el siguiente Link: https://docs.google.com/spreadsheets/d/15YOwF-XkkAjEEV_e8-NCs7PA9ruhX1aY624HxlUjnoU/edit?pref=2&pli=1#gid=3

3.3 Aspectos Significativos y Reacción

La flexibilidad del diseño permitió que los estudiantes tuvieran acceso a diversidad de herramientas que fueron enriqueciendo desde el apoyo entre pares para aconsejar por donde ir avanzando, qué herramienta usar o cómo desarrollar una guía. El diseño de su proyecto de vida como un primer acercamiento a la definición de un futuro personal y profesional marcó el aspecto más significativo del proceso

3.4 Transferencia y uso Futuro

Como se enunció en el caso anterior, en esta institución se ha logrado hacer un trabajo con mapas conceptuales y con itinerarios desde diferentes grados y áreas, Con este caso se evidencia totalmente el modelo SAM2. Una de las docentes está trabajando su tesis de maestría en torno a los itinerarios para el desarrollo de la lógica.

4 Agradecimiento

La tutora, compañera y amiga, Olga Lucía Agudelo Velásquez, por permitir implementar esta experiencia innovadora en nuestras aulas. A los creadores y desarrolladores, Joseph D. Novak, David Ausubel, y Alberto Cañas, y a la Institución educativa brindar los recursos técnicos.

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EMOTIONAL CONCEPT MAPS WITH DIFFERENT POINTS OF VIEW: COMPARING DIFFERENCES AT MULTIPLE TIME POINTS

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Abstract. Concept mapping is commonly used to represent ideas or concepts in a graphical representation at the knowledge level. However, text-based concept maps (Cmaps) cannot indicate students' preferences or feelings regarding the concepts or propositions. In this paper, I share an innovative experience of applying emoticons to concept maps for students to also communicate at an affective level. Thirteen students enrolled in an interactive e-book design course participated in this activity, which was organized into four main phases. In phase 1, students formed small groups and chose a story topic. In phase 2, each student drew personal Cmaps from the perspective of the role he/she had chosen. In phase 3, students commented on group members' Cmaps by adding emoticons (heart and question mark). Meanwhile, a follow-up question and answer session was held. Emoticons on the Cmaps were used to identify students' preferences or actual thinking on certain concepts, and thus helped them to focus on discussing preferred ideas or clarifying doubts. Students could effectively exchange ideas and resolve conflicting concepts for a coherent storyline. In phase 4, each group drew a final Cmap by integrating the points of view of different roles, and then created an interactive e-book based on the map. It is suggested that adding emoticons and automatic concept map comparisons at multiple time points as new features of the Cmap tools would facilitate the discussion process and help learners observe how the concepts evolve over time.

1 Introduction

Concept mapping is commonly used to represent ideas or concepts in graphical representations. However, text-based concept maps (Cmaps) cannot show users' preferences or feelings regarding the concepts or propositions. Users cannot directly notice how others feel about their ideas. Therefore, the advantage of using Cmaps is somewhat limited to a knowledge level, and lacks communication at an affective level. Recently, as the use of online social media (e.g., Facebook) has become widespread, emotional icons (emoticons) have begun to play an important role in communication through technology. Emoticons are traditionally pictorial representations of facial expressions using punctuation marks and letters to express a person's feelings, and have evolved into stylized pictures that do not use punctuation. In this paper, I share an innovative experience of applying emoticons to concept maps for students to indicate how they feel about other group members' ideas. Therefore, concepts or propositions could be revised to address these issues in a more effective discussion process, and a better concept representation could finally be achieved.

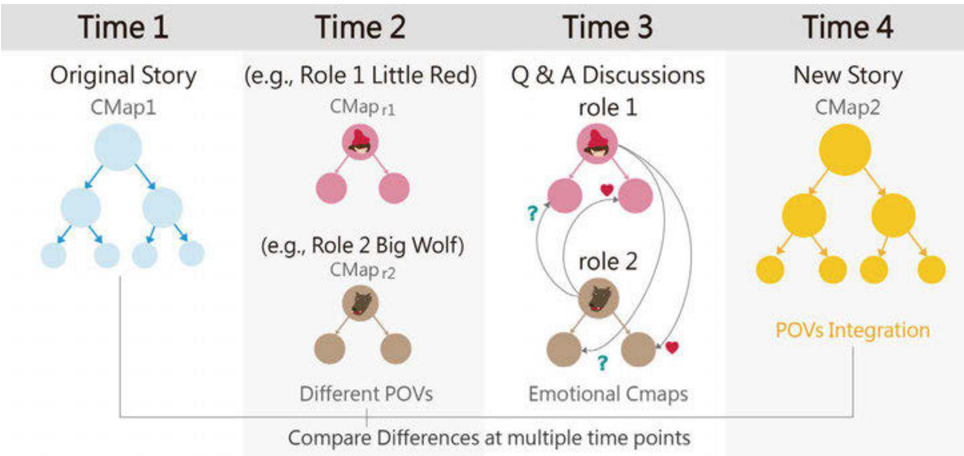

Figure 1. Conducting a story rewriting activity to reflect different role's points of view.

2 My Experience

Thirteen students enrolled in an interactive e-book design course participated in this activity. The activity was organized into four main phases (Figure 1). In phase 1, the students formed small groups of two to three and chose a story topic (e.g., "Little Red Riding Hood"). In phase 2, each student in a group drew personal Cmaps from the perspective of the role he/she had chosen (e.g., Little Red or Big Wolf) without discussion. In phase 3, students commented on group members' Cmaps by adding emoticons (heart and question mark) (see Figures 2 and 3). Since CmapTools did not provide functions to insert emoticons, students were told to use any photo editing tool to add emoticons and to insert numbering icons to mark the storyline sequence. Meanwhile, a follow-up question and answer session was held. For example, one question was marked in Big Wolf's Cmap as "Why did Little Red want to run away from home? And where did she go?" One example for the preference marked with a heart in Little Red's Cmap was "Wolf disliked skinny Red, so he ordered her to eat the expired food." Emoticons on the Cmaps were used to identify students' preference or actual thinking on certain concepts, and thus helped the students to focus on discussing preferred ideas or clarifying doubts. Students could effectively exchange ideas and resolve conflicting concepts for a coherent storyline. In phase 4, each group drew a final Cmap by integrating the different roles' points of view. Based on the final Cmap, each group created an interactive e-book with a new storyline. Furthermore, the students could compare the differences in the Cmaps at multiple time points to observe the concept changes in this creative story rewriting activity.

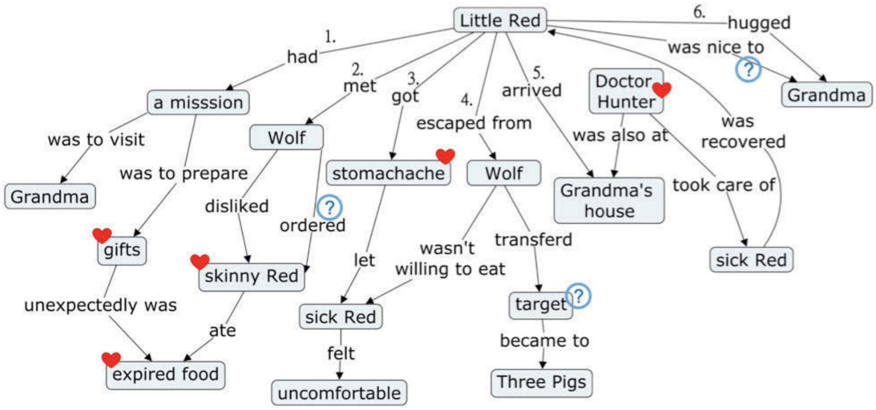

Figure 2. Little Red's concept map with emotional icons.

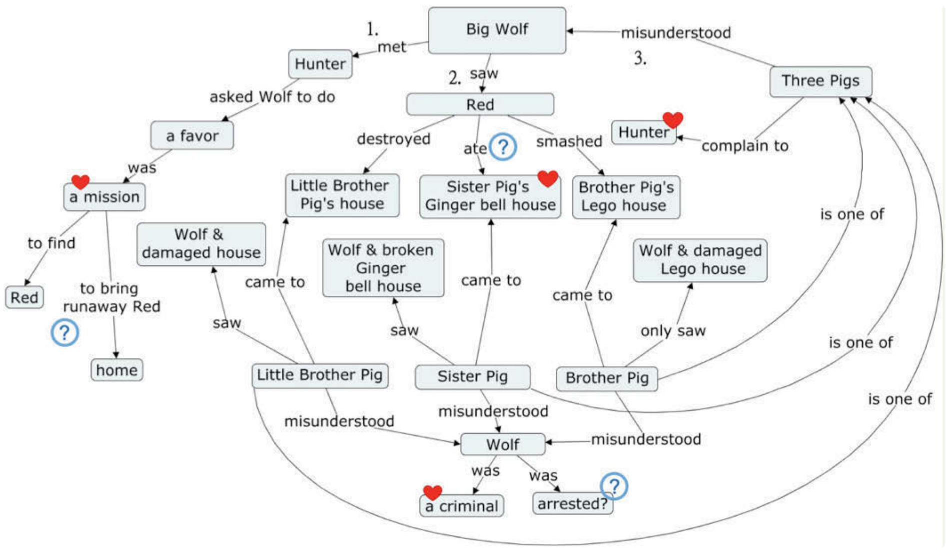

Figure 3. Big Wolf's concept map with emotional icons.

3 Suggestions for CmapTools

I think it is really helpful to add emoticons to Cmaps for better communication at the affective level, and this would take the application of Cmaps to a whole new level. Students could quickly grasp a general idea of what others think about their personal Cmaps and focus on discussing preferred ideas or clarifying doubts. Emotional concept maps could also be applied to other learning activities or brain storming sessions, not limited to this story rewriting activity. Therefore, it is suggested that new features such as inserting emoticons and numbering sequences be added to CmapTools. Moreover, new functions to automatically compare and mark concept differences at multiple time points would be helpful to know how concepts evolve over time.

FROM CONTENT TO CONCEPTS: USING CONCEPT MAPPING TO HELP STUDENTS LEARN TO THINK LIKE HISTORIANS

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Abstract. Very often students arrive in collegiate history courses with a simplistic idea of what history is and what historians do. In particular, students have little understanding of the complexity of historical analysis and fail to understand the variety of issues that historians need to consider when writing about the past. These issues – such as context, chronology and causation, and continuity and change over time – can be treated as core concepts that students need to understand and develop a facility with in order to start to think like an historian. This project addresses this by using concept mapping as a way to help students learn these key ideas and concepts. This presentation focuses on an introductory United States history course. The author describes how concept mapping was utilized as a way to develop these skills in undergraduate history students.

1 Introduction

The "coverage" model of pedagogy has come under increased scrutiny in recent years (Weimer, 2013; Ambrose et al., 2010). This is particularly the case in many introductory history courses where the sheer volume of "material" to "cover" is daunting (Sipress & Voelker, 2008). For example, in the course under consideration in this presentation –History of the United States from 1865 to the Present - potentially anything that happened between 1865 and the present involving the United States could be included in the material to be "covered". In addition, courses such as this one which end "in the present" have an ever-shifting end point with new "material" to be "covered" every few years. Many historians teaching introductory-level courses such as this one have come to the conclusion that this has reached an untenable situation, necessitating a thorough rethinking of the pedagogy employed in such courses.

In addition, many collegiate history courses are bounded by time and place, where the focus has traditionally been on having students learn "what happened" in that given place during a given time period. Courses where students learn to "think like historians" tend to be upper division courses reserved for history majors. Unlike in many of the other social sciences, introductory history courses do not often focus primarily on helping students learn the fundamental concepts that historians use to understand the past. Key historical concepts - such as context, chronology and causation, continuity and change over time – are seldom addressed in a systematic way and instead are often lightly addressed if at all. This course was designed to place the focus on helping students learn these fundamental concepts first, then used the remainder of the semester to have the students "think like an historian" and apply these concepts to a series of student-selected research projects involving construction of concept maps. While concept mapping has been used in many higher education settings to help students understand a wide variety of subjects, concept maps have seldom if ever been used in collegiate history courses. Indeed, after conducting a thorough search of the literature I failed to find a single reference in which concept mapping had been used in collegiate history courses in any fashion at all.

2 Concept Maps in the Course

I used concept mapping in two different ways in this course. First, concept maps were constructed by the students on historical events of their choosing. Constructing these maps helped students understand that history is not a simple liner, chronological unfolding of events in time, but rather better understood as a complex web of interrelated events and causes occurring through time. Concept mapping is particularly well suited to illustrating this. As soon as students move away from a written narrative of an event and begin to construct concept maps they more easily see the interconnectedness and complexity of any single event. The idea of "context", for example, becomes clearly apparent as students place an event in the web of other events and patterns connected to it. The second way I used concept mapping in this course was to have students construct maps on specific historical concepts after they had worked with historical events. This was a much more challenging assignment as the students needed to consider how historians use specific historical concepts to inquire about the past. Students constructed concept maps around focus questions such as "How does context inform an historians understanding of an historical event" or "How do historians use chronology and causation to explain an historical event." This was often challenging but very helpful for students because of the metacognitive nature of this concept map, i.e. thinking about how historians know something or how historians come to an understand about an event or historical issue. When confronted with thinking about how historians think students need to draw upon their own understandings, developed through the earlier use of concept maps, and can achieve a richer understanding of what it is historians do and how they do it.

I introduced concept mapping in the course in a three-step process. First, I informally introduced the idea by having the students help me identify a list of concepts associated with the second stage of the industrial revolution (circa 1880-1910). This is a major topic addressed early in the course. It is also a very complex, multifaceted topic as it incorporates such a wide array of concepts such as urbanization, immigration, technological change, labor issues, changes in the finance system, development of mass marketing, child labor concerns and on and on. I then modeled the construction of a concept map at the front of the room at the board, engaging with the students to consider where each concept should go in relation to the others, and what sorts of connecting words best describe the relationship between them. The students quickly began to make many connections between the concepts, and we kept needing to add more concepts as we proceeded. In the second step I divided the students into small groups, had them choose a topic from the material we had been studying for that week and together construct a rudimentary concept map on their chosen topic. After, a few volunteered their work which I reproduced on the board, then as a class we critiqued them for completeness, appropriateness of the linking words and subsequent propositions. For the third step I more formally introduced concept mapping by having the students read “What is a Concept Map” by Cañas and Novak from the IHMC website (Cañas & Novak, 2009). We met the next class period in one of the campus computer labs where I introduced them to the IHMC *Cmap Tools*, then set them to the task of constructing a formal concept map on an event of their choosing. Figure 1 below is an example of one student’s first “event-specific” concept map, this one delving into why Richard Nixon was elected President of the United States in 1968. After that first concept map the students constructed two more maps on events of their choosing across the remainder of the semester. They finished the semester with a concept map on a specific historical concept as described above.

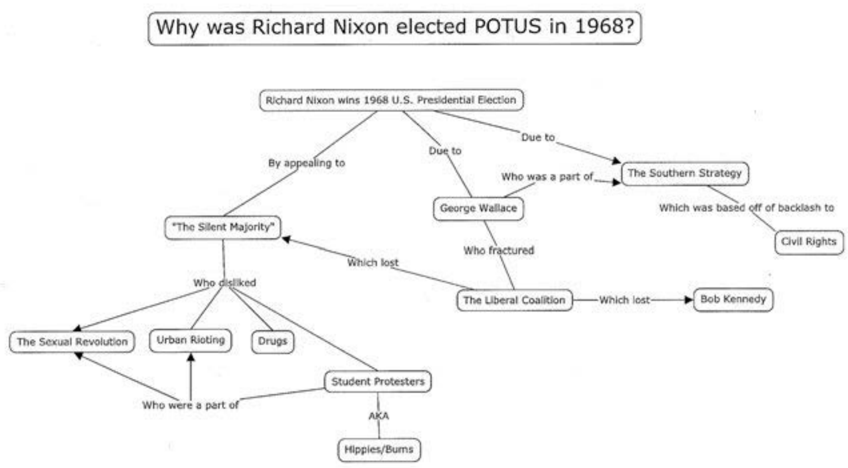

Figure 1. Example of student-produced first round “event-specific” concept map.

3 Summary

Concept mapping proved to be very useful in helping collegiate history students learn to think like historians. As a class the students and I quickly saw that concept mapping will never replace narrative in historical understanding, however concept mapping proved to be a very powerful analytical tool helping to display the complex nature of many historical events in a way that traditional narrative often could not. Concept mapping proved to be especially useful in helping students gain a more thorough understanding of such key historical concepts as context and gave students a new way to describe and inquire about the past.

4 Acknowledgements

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LA EDUCACIÓN PREESCOLAR COMO ESCENARIO PARA ITINERARIOS FLEXIBLES DE APRENDIZAJE BASADOS EN MAPAS CONCEPTUALES

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Resumen. Son muchos los esfuerzos de los docentes por encontrar maneras efectivas de apropiar las Tecnologías de la Información y la Comunicación – TIC- en sus aulas de clases, en la búsqueda por mejorar los procesos pedagógicos. El aprendizaje autónomo de los estudiantes y la flexibilidad en los currículos se ha convertido también hoy día en una necesidad apremiante. Combinando el interés por aportar en la solución de estos dos problemas, surgen propuestas de nuevos ambientes de aprendizaje y diseños instruccionales apoyados en TIC. Se genera entonces el diseño e implementación de experiencias en torno a itinerarios flexibles de aprendizaje basados en mapas conceptuales, en distintos niveles de educación y contextos, abordando competencias diversas, tal como lo recomiendan Agudelo y Salinas (2015). Basado en la propuesta de utilizar mapas conceptuales en la planeación de un currículo de Cañas & Novak (2010), el caso que se presenta en este escrito hace parte de ese estudio y se refiere a la aplicación de un itinerario flexible de aprendizaje en el nivel preescolar, para trabajar el Proyecto de aula "Conozco mi cuerpo"

1 Contexto de la Investigación

Este itinerario se desarrolla en la institución educativa Madre María Mazzarello. Entidad de carácter oficial, femenino, que ofrece una educación integral en los niveles de preescolar, básica y media, fundamentada en la pastoral y apoyada en los valores del Espíritu Salesiano. Las estudiantes participantes, 52 en total, todas de sexo femenino, pertenecen a los dos grupos de preescolar y sus edades oscilan entre los 5 y los 6 años. Sus familias están ubicadas en una clase social media. Las docentes participantes son dos, formadas en educación infantil y una de ellas con una especialización en informática, la otra docente no manejaba bien este tipo de herramientas pero encontró apoyo en su par y en su actitud abierta para trabajar con nuevas metodologías y tecnologías.

2 Diseño de la Propuesta

Con el apoyo de un grupo de 5 docentes de la red de primera infancia de Medellín, se diseñó un itinerario flexible, basado en mapas conceptuales para el proyecto MI CUERPO, que se desarrolla en preescolar. (Figura 1), el cual está orientado al desarrollo de una competencia de la dimensión corporal: "Reconocer mi cuerpo", y se diseña a partir de tres bloques: cuidar mi cuerpo, sentir mi cuerpo y reconocer la diversidad.

Las guías incluidas en el itinerario se diseñaron con videos orientadores donde una niña y una profesora van explicando las actividades a desarrollar. Los objetos de aprendizaje incluyen fichas que los docentes trabajan habitualmente y juegos e interactividades en línea. Para facilitar la ubicación de los niños frente al itinerario, se trabajó con colores primarios delimitando cada módulo.

3 Ecosistema de Aprendizaje que rodeó la Implementación.

Metodología: En este caso, las docentes trabajaron apoyadas por los padres de familia, por lo cual iniciaron con un taller con ellos, orientado por una psicóloga, mostraron el itinerario y lo que se pretendía con él y les dieron el enlace a través del cual podrían acceder para apoyar el trabajo desde la casa.

El aula se dispuso con espacios similares a los tres componentes centrales del itinerario y en dichos espacios se iban resaltando los trabajos de los estudiantes. Al finalizar el periodo académico se realizó el Carnaval del cuerpo como una actividad institucional.

El nivel preescolar no tiene disponibles todo el tiempo los computadores, solo un día a la semana, por lo cual los estudiantes podían avanzar en las actividades digitales en casa, apoyados por sus padres, o en el aula regular de clase con los recursos dispuestos para ello. Por ejemplo, una ficha para colorear se podía hacer con la herramienta paint, de manera digital o en la hoja impresa que encontraba disponible en el espacio correspondiente en el aula.

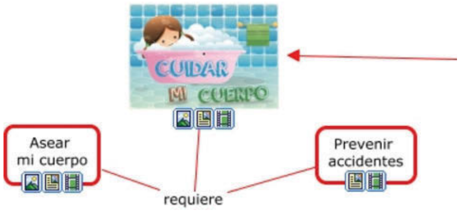

Figura 1. Vista parcial de Itinerario para el proyecto del cuerpo - Fuente propia. http://mapas.futurodigital.org:8080/rid=1N4QVQ2Y0-1RHK5DG-1CN/Proyecto%20mi%20cuerpo.cmap

Rol del docente: Las docentes trabajaron en equipo con los padres y junto con ellos acompañaron el trabajo y las elecciones de los estudiantes. Además del diseño del itinerario, su aporte se centró en la disposición del aula para recrear el avance que se iba evidenciando. Se encargaron además del control del tiempo. La organización del evento final estuvo también a su cargo.

Rol del estudiante: Los estudiantes podían elegir no solo el módulo a trabajar sino, además las actividades para desarrollar y los objetos de aprendizaje.

Evaluación: Realizar una muestra gastronómica, organizar una muestra artística, ser el protagonista de la semana, demostrar sus sentimientos, son actividades que permiten evidenciar las competencias adquiridas y participar al final del periodo académico en el Carnaval del cuerpo.

4 Reacción y Aspectos Significativos

El trabajo con la comunidad, no solo en el apoyo desde el hogar para avanzar en las actividades y acciones, sino también el recibir asesoría de la psicoorientadora, fue un aspecto destacable en esta experiencia.

Los productos que evidenciaban el logro de las competencias estuvieron muy bien planeados, por ello se pudo hacer la socialización con todo el colegio en el Carnaval del cuerpo y esto fue una oportunidad para dar a conocer los logros de los estudiantes de preescolar y las ventajas de esta nueva forma de trabajar.

Las docentes motivaron a otros compañeros para usar los itinerarios en otros grados y áreas, por lo cual se inició con la formación en mapas conceptuales a todos los docentes de la institución. Igualmente se propone otros proyectos del nivel preescolar como: contando me divierto y el mundo de las letras, por lo cual ya se están iniciando las mesas de trabajo con las docentes.

Los itinerarios flexibles basados en mapas conceptuales cobran vida y mueven fuerzas desde los docentes, los diseñadores instruccionales, las instituciones educativas y obviamente: los estudiantes como centro y protagonistas de su propio aprendizaje para generar experiencias que permiten avanzar en el logro de ese gran propósito del aprendizaje abierto, de laeducación flexible: donde el usuario tiene elección, tiene libertad de maniobra, tiene control sobre la forma en que aprende. Estamos, entonces, ante procesos centrados en el alumno, (Salinas, 2013)

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MAPAS CONCEPTUALES Y DESARROLLO DE FUNCIONES INTELECTUALES COMPLEJAS

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Resumen. El presente trabajo es una breve narración sobre el ejercicio profesional, durante el cual he implementado cambios significativos al vincular la forma de ejercer la docencia con los avances tecnológicos de la información y la comunicación. He confirmado que para enseñar científicamente la psicología, uno se puede auxiliar de herramientas digitales como el CmapTools. En el caso de la Psicología existe una diversidad de escuelas y eso es lo que enseñamos a los estudiantes una polisemía de los conceptos definitorios de la misma. Con el uso de CmapTools se logró en gran parte diferenciar los criterios de las diferentes aproximaciones en la definición de conceptos y desarrollar varias funciones intelectuales complejas como pensamiento, inteligencia, razonamiento y hasta imaginación e innovación. El manejo de contenidos fue más preciso, coherente, su discurso más fluido, seguro y transferible a situaciones novedosas en su proceso de aprendizaje profesional. Finalmente quisiera señalar que al inicio realizar un mapa conceptual requiere mayor esfuerzo para ambos, profesor y estudiantes pero después se facilita el trabajo y los resultados se observan en un desempeño académico más eficiente.

1 Introducción

Soy profesor de la FES Iztacala UNAM, tengo 9 años aproximadamente utilizando los mapas conceptuales con CmapTools, concurrentemente estaba realizando una investigación sobre aprendizaje conceptual con el uso de hipertextos y noté que los mapas conceptuales eran parte del hipertexto y permitían organizar la información de manera ordenada, coherente, simplficada, lógica y a su vez, permitía manejar una gran cantidad de información relacionada con cada concepto con la estructura construida en el mapa conceptual. De aquí surgió la pregunta que frecuentemente nos hacemos los docentes ¿Cómo conocen los estudiantes en la educación?, esta pregunta cambia y se complejiza en la actualidad al incluir los medios digitales en la operacionalización, desarrollo, producción y comunicación de la forma como conocemos. Esto da lugar a la siguiente pregunta ¿cómo conocían, diferenciaban e integraban la información los estudiantes de la carrera de psicología con una variedad de conceptos polisémicos?, donde cada aproximación teórica daba la definición de sus conceptos que la conformaban.

Pensando que los estudiantes deben conciliar las diferentes "definiciones", surgió mi siguiente pregunta ¿cómo pueden integrar y diferenciar los estudiantes, el mismo concepto siendo acorde con la postura teórica que está en turno?, esto me llevó a suponer que los estudiantes tenían una estrategia para diferenciar sus respuestas según el contexto (profesor). Sin embargo, mi propósito iba en el sentido de conocer los criterios con los que cada aproximación teórica definía sus conceptos y para eso necesitaba una herramienta conceptual. Considerando la polisemia de la diversidad conceptual en psicología, pude darme cuenta que el Cmaptools era afin con los criterios lógicos de la ciencia y la filosofía. Entonces empezamos a intentar realizar representaciones lógicas de los conceptos partiendo de las proposiciones y respetando éstas en el desarrollo de la estructura conceptual sobre un tema específico. Durante la realización de los mapas conceptuales, fue notable la necesidad de ciertas precurrentes para elaborar los mapas conceptuales siendo las siguientes: leer detalladamente los contenidos, identificar los conceptos principales, analizarlos, comprenderlos, ordenarlos jerárquicamente para pasar a integrarlos de manera coherente y llegar a una conclusión.

2 Metodología Didáctica

Al inicio de la observación se dividió el grupo de 36 estudiantes en dos subgrupos A y B al azar. Al grupo A les expliqué la intención de utilizar los mapas conceptuales, el trabajo extra que implicaba la realización de mapas conceptuales y recibieron asesorías para la construcción de los mismos. Al grupo B solo revisaba sus resúmenes de las lecturas y daba asesoría sobre textos. Durante los seminarios registraba su participación verbal de todos. Esta fase duró un año y para el siguiente elegí solo 7 alumnos al azar y se observó las categorías conductuales que más ocurrían, siendo quince. El objetivo fue conocer los factores y criterios de su aprendizaje mediante la construcción de sus mapas conceptuales y su discurso sobre los mismos. Entonces en el siguiente periodo escolar les solicité que redactaran en una hoja los requisitos antes mencionados. Esto ayudó a depurar las categorías de observación y se redujeron a nueve facilitando su registro y análisis. Esto permitió conocer el nivel de conocimiento de los contenidos al inicio y al final del curso. La complejidad de los mapas fue más específica conforme avanzaba el seminario. Las tutorías ya no se limitaron a la construcción de mapas conceptuales, sino además a conocer los criterios definitorios de los conceptos. En el tercer año, se usó un sistema de registro con videograbaciones de la participación de los estudiantes para el análisis de las categorías de observación.

3 Algunos Resultados

Al inicio la elaboración de los mapas era muy limitada y desorganizada, los criterios de construcción estaban ausentes eran intuitivos. Los estudiantes que usaban los mapas se molestaban por ese trabajo "extra", los demás no trabajaban tanto. En este proceso, fueron surgiendo algunos resultados muy interesantes dado que el programa mismo les permítió, como hacer megamapas horizontales, exportar a otras aplicaciones, como PowerPoint, Prezi, Camtasia, Publisher, y páginas Web, entre otros, para la presentación de sus trabajos, de hecho hay varias publicaciones de ellos en Red. A continuación, se muestra uno de los mapas construido sobre una de las aproximaciones teóricas.

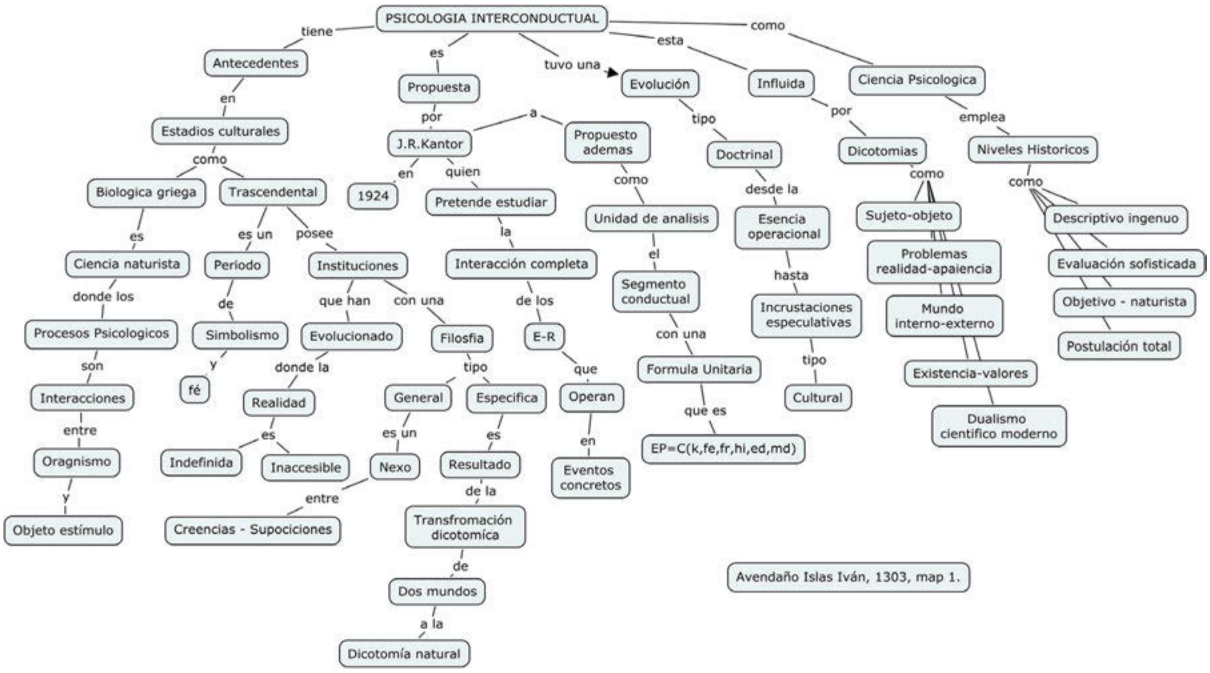

Fig. 1 muestra mapa elaborado por estudiante de psicología en la materia de Teoría III.

4 A Modo de Conclusiones

Considero que la aplicación del CmapTools es muy extensa y por consiguiente los resultados. En el caso de Psicología me ha permitido precisar la definición de varios conceptos para explicarlos a los estudiantes, logrando el objetivo principal, diferenciarlos en la psicología y su relación con otras disciplinas. Este ejercicio fue muy útil con los profesores durante la elaboración del Cambio de Plan de Estudios de Psicología en la FESI. En los estudiantes se observó un desarrollo de competencias intelectuales como pensamiento, inteligencia, razonamiento y hasta imaginación e innovación. El manejo de contenidos fue más preciso, coherente, su discurso más fluido, seguro y transferible a situaciones novedosas. Otro resultado muy interesante fue que el estudiante reportara que le había permitido organizar información fuera de la escuela por medio de las redes y en temas extraescolares, logrando cierta autonomía en su formación.

A CONCEPT MAP AND LINGUISTIC APPROACH FOR IMPROVING PERSIAN-SPEAKING CHILDREN' S CRITICAL THINKING

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Abstract. Lipman (1997: 98) believes that everyday thinking and critical thinking are different. Everyday thinking is common and simple but critical thinking is more complex and requires higher cognitive processing and reasoning based on the evidence. He believes that some of the critical thinking activities that a person is involved with are: issue expression, data collection, analyzing question, viewing and judging the credibility of a source, organizing information and studying results and conclusions. Concept map can easily provide these. Achieving standards of critical thinking and concept map are possible when children have sufficient language ability in order to express logical and semantic relations. Discourse particles are important to enhance children's verbal skills to express addition relations, causal relations, logical and semantic relations so they are also necessary for their critical thinking and drawing their concept map. The present research aims to examine comprehension and production process of discourse particles in 8 Persian monolingual speaking in two age groups (7-8 and 8-9 years old) using syntactic-semantic model. To achieve this goal, children storytelling while drawing their concept map, were recorded, then the number of discourse particles in the corpus of their storytelling were studied. Data analysis provides strong evidence that children use different types of discourse particles in their stories even in low amount and an intergroup data analysis indicated that there was no significant difference in the performance of the two groups. Also the frequency of the discourse particles that expressed simple relations is more than the frequency of discourse particles that expressed complex relations. The reason for that can be explained by iconicity principle in which the order of sentence elements follows the sequence of real world events. Children use simple relations more than complex relations because based on the iconicity principle the order of sentence segments has more adaptation with their event sequence in real world and their meaning is more simple so can be shown by concept map more easily.

Keywords: Discourse particles, critical thinking, child storytelling, discourse.

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ACTIVIDADES DE APRENDIZAJE CON MAPAS CONCEPTUALES: VISIÓN GENERAL Y NUEVA PROPUESTA A PARTIR DEL ANÁLISIS CON EL SEGUIMIENTO DE LA MIRADA (EYE TRACKING)

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Abstract Las actividades de aprendizaje con mapas conceptuales constituyen una pieza valiosa en el entramado de la planificación de cualquier acción formativa. En la bibliografía especializada se pueden identificar tres tipos básicos de actividades con mapas conceptuales: creación de mapas, consulta de mapas y completar mapas. El nuevo tipo de actividad que proponemos consiste en que el profesor crea un mapa que tenga errores conceptuales (o no) y posteriormente pide a los estudiantes que detecten estos posibles errores.

Para validar este nuevo tipo de actividad se ha realizado un estudio aplicando la metodología del eye tracking (seguimiento de la mirada). Desde los años ochenta existen varias líneas de investigación en la psicolingüística que estudian el complejo proceso de la lectura humana por medio del seguimiento de la mirada (Clifton Jr., Staub, & Rayner, 2007; Juhasz, Gullick, & Shesler, 2011; Rayner, Chace, Slattery, & Ashby, 2006; Rayner, 1998; Staub & Rayner, 2007). Por otro lado, en los últimos diez años han publicado los primeros estudios aplicando el eye tracker a los mapas conceptuales (Rovira, 2016).

Los mapas conceptuales son un tipo de esquema gráfico que permite representar el conocimiento (Novak & Cañas, 2006; Novak & Gowin, 1984; Novak, 1990a, 1990b). Están formados por conceptos y relaciones entre conceptos, habitualmente llamadas frases de enlace. Los conceptos suelen mostrarse en el interior de un cuadrado y las frases de enlace etiquetan las líneas o flechas que conectan dos o más conceptos. Los conceptos son la parte sustantiva de las frases (nombres y adjetivos) y las frases de enlace suelen contener verbos o preposiciones. Los orígenes de los mapas conceptuales hay que buscarlos en las teorías de David P. Ausubel sobre el aprendizaje significativo (Ausubel, 1963, 2012; Ausubel, Novak, & Hanesian, 1968). Se han desarrollado multitud de programas informáticos para facilitar su creación y edición (Mesa & Rovira, 2006; Rovira, 2005) y se han aplicado como instrumentos para facilitar la navegación hipertextual (Rovira, 2002).

Un mapa conceptual es un gráfico que se lee y por tanto es susceptible de ser analizado de la misma forma que la lectura estándar (Rovira, 2016). A partir del análisis del número y la duración de las fijaciones o de la dirección del movimiento sacádico se pueden obtener indicios muy sólidos sobre la atención del sujeto e incluso sobre el tipo de procesamiento cognitivo que está realizando. Hay un amplio consenso en que un incremento en la duración de las fijaciones o del número de comportamientos regresivos de relectura indican que el sujeto se está enfrentando con una tarea que implica una mayor carga cognitiva, una tarea que el sujeto percibe como más compleja (Ball, Lucas, Miles, & Gale, 2003; Epelboim & Suppes, 2001; Hegarty & Just, 1993; Holmqvist et al., 2011; Rayner et al., 2006; Rayner, 1998; Underwood, Jebbett, & Roberts, 2004).

Los primeros resultados indican se producen diferencias significativas en el número de fijaciones, el tiempo de las fijaciones y en el número de regresiones entre la consulta de un mapa conceptual para realizar la actividad básica responder a un cuestionario que en una actividad de buscar un posible error en el mapa. Por tanto, a partir de estos datos preliminares podemos afirmar que los sujetos invierten más esfuerzo cognitivo a las actividades de búsqueda de errores que a otro tipo de actividades con mapas conceptuales.

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ARE YOU A GOOD CMAPPER? CERTIFY YOURSELF!

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Abstract. Becoming a good concept mapper (Cmapper) is not easy. Building his/her first concept maps, the new Cmapper needs to handle some of the mechanics of constructing a Cmap, and understanding how to put together concepts and linking phrases to form propositions. Next comes understanding the meaning of hierarchy as it relates to concept mapping, and grasping the importance of crosslinks. These are structural aspects of the concept map. At the same time, the new Cmapper starts struggling with the content, with expressing in the concept map his/her knowledge about the topic being mapped, with finding the right set of concepts and the linking phrases that best explain their relationship. We have written about these issues before: in Cañas et al. (2012) we discussed the importance of content and structure in concept mapping; in Cañas et al. (2015) we analyzed what makes a good and excellent concept map and a good and excellent Cmapper; and in Cañas et al. (2016) we analyzed the importance of the purpose of the map in determining its size and how excellent Cmappers tend to build smaller maps. With this background, and to help determine the progress towards becoming a better Cmapper, we are setting up a Concept Mapping Certification suite, hosted by the Concept Mapping Academy. The certification consists of several levels: Level 1 evaluates the Cmapper's understanding of the structural aspects of concept mapping. Level 2 assesses the Cmapper's ability to organize content in a meaningful way. Level 1 has been implemented and is in beta testing at www.cmapacademy.org. More levels are being designed.

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BLENDING TWO METACOGNITIVE TOOLS USING CMAPTOOLS: THE VIRTUAL VEE MAP AND CONCEPT MAPPING

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Abstract. The world is changing very fast, and Educators should be aware of this. There is a rapid scientific and technological change that, together with globalisation, demands superior educational standards. Workers with high-order critical thinking skills are needed. In order to achieve this major goal, educators are asked to promote an Inquired-based learning and to make potential meaningful material in high School and University. Educators should therefore improve their teaching design and practice that enhances deep learning. It is known that students learn more in autonomous work, collecting and interpreting the data in order to find an answer to the proposed inquiry question. In this work we will forward a proposal on how to optimize the use of the virtual Vee-diagram together with Concept Mapping.

Our method is a blending of two different frameworks, the virtual Vee Map of Gowin and concept mapping, using the software CmapTools. The high school students were asked to use the Vee diagram as: 1) a laboratory report for biology experimental lessons 2) as a template for Internet inquiry. In both situations, students were asked to elaborate and relate all the conceptual and methodological parts of the Vee map using concept maps.

The virtual Vee Map proved very successful in promoting student learning in experimental design and in the area of inquiry, enabling students to organize and select resources of data in the Internet. The blending of the two metacognitive tools also facilitated the construction of crosslinks between the Conceptual and Methodological parts of the Vee. Challenging students to present the work using a Vee map blended with concept maps strengthen student inquiry skills at the analysis, synthesis, and evaluation levels, since students need to evaluate their data set in light of their conceptual research. Moreover, students were able to place their small contribution to the study into a larger context, thus enabling the detection of the “missing pieces”. Promoting students understanding of scientific methodologies is part of the work toward scientific literacy, which is one of the major aims of high school teaching.

CHINESE CONCEPT MAP GENERATION BASED ON OPEN INFORMATION EXTRACTION

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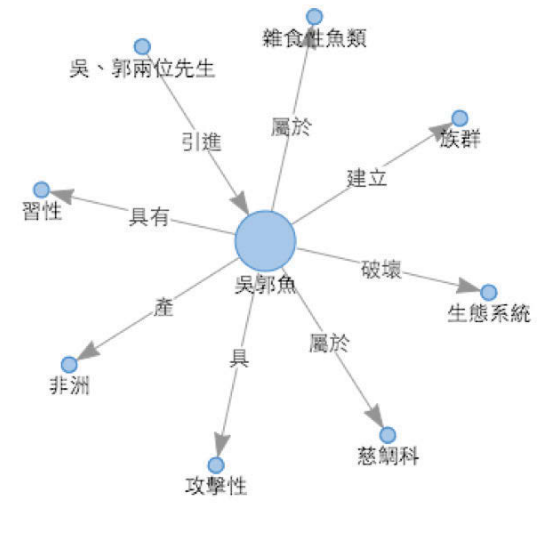
Abstract. Creating a concept map automatically from Chinese texts is challenging, because 1) Chinese words require no delimiters in between (like those spaces in English), which makes word, phrase, or concept identification difficult; 2) Chinese is discourse-oriented, meaning there is no strict grammar imposed on a sentence, which makes relation extraction difficult. For example, the three Chinese sentences "蘋果營養豐富" ('Apple nutritious'), "蘋果是營養豐富的" ('Apple are nutritious') and "蘋果富含營養" ('Apple are rich in nutrition') are semantically synonymous sentences, but the first one, which lacks an overt verb, is used more often than the other two in real-world situations.

In this study, we present an Extended Chinese Open Relation Extraction (ECORE) approach that is able to extract entity-relation triples (i.e. a relation that links two concepts) from Chinese free texts based on a series of natural language processing techniques, *i.e.,* word segmentation, POS tagging, syntactic parsing, and linguistic rules. Take the sentence as an example: "**蘿蔔是蔬菜，也是根莖類植物**" ('Radish is vegetable, and is a rootstock plant.), our ECORE software can correctly extract two triples: <**蘿蔔**('Radish'), **是**('is'), **蔬菜**('vegetable')> and <**蘿蔔**('Radish'), **是**('is'), **根莖類植物**('rootstock plant')>, although the subject in the second clause is elided. Another example is a paragraph describing the 吳郭魚 ('Tilapia') in a textbook of elementary school. Figure 1 shows the original texts, 8 extracted triples and a generated concept map.



Original Texts:

吳郭魚屬於慈鯛科，原產於非洲。當初由吳、郭兩位先生引進台灣，後來就以他們的姓命名。吳郭魚屬於雜食性魚類，性情兇猛，具攻擊性，耐汙染、成長快、繁殖力強，具有護卵及小魚的習性，加上體型比原生種魚類來得大，因此他們在短暫適應環境後就迅速建立族群，破壞了原本河川的生態系統。

Extracted Triples: **<Argument 1, Relation, Argument 2>**

1. <吳郭魚(Tilapia), 屬於(belong to), 慈鯛科(Cichlid)>
2. <吳郭魚(Tilapia), 產(origin), 非洲(Africa)>
3. <吳、郭兩位先生(Mr. Wu and Mr. Guo), 引進(import), 吳郭魚(Tilapia)>
4. <吳郭魚(Tilapia), 屬於(belong to), 雜食性魚類(polyphagia fish)>
5. <吳郭魚(Tilapia), 具(be), 攻擊性(offensive)>
6. <吳郭魚(Tilapia), 具有(have), 習性(habitual behaviors)>
7. <吳郭魚(Tilapia), 建立(establish), 族群(group)>
8. <吳郭魚(Tilapia), 破壞(destroy), 生態系統(ecosystem)>

Figure 1: Example sentences, extracted triples, and a generated concept map.

To illustrate the performance of our ECORE concept mapping software, we randomly selected paragraphs from the science textbooks of elementary schools, and then manually annotated the relation triples for each Chinese sentences. In total, 141 entity-relation triples were obtained as gold standard. Performance evaluation of our ECORE software was conducted based on: 1) exact match; and 2) relation-only match. For exact match, each component of the extracted triple must be identical with the gold standard. For relation-only match, the extracted triple is regarded as a correct case if an extracted relation agreed with the relation of the gold standard. We compared ECORE with the first Chinese open relation extraction method ever built: CORE (Tseng et al., 2014). Table 1 shows the experimental results. Our ECORE system obviously performs better than CORE no matter which metrics (exact match or relation only) were concerned.

Chinese Open IE		Precision	Recall	F-Score
Exact Match	ECORE	0.3065	0.4326	0.3588
	CORE	0.1649	0.2199	0.1884
Relation Only	ECORE	0.6784	0.9574	0.7941
	CORE	0.3936	0.5248	0.4498

Table 1: Experimental Results for performance evaluation

In conclusion, this study proposes a concept map generation method based on open information extraction techniques. Experimental results show that our ECORE software is effective for entity-relation extraction, and demonstrates its feasibility for Chinese concept map generation. The resulting software could be used to automatically generate concept maps from science textbooks for elementary schools to facilitate the teaching and learning based on the concept map approach.

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COMPETENCIAS, LENGUAJE, MAPAS CONCEPTUALES Y RAZONAMIENTO

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Abstract. El Objetivo fue analizar la relación entre el desarrollo de los medios digitales y el requerimiento de nuevas competencias intelectuales vinculadas con la educación. Con la evolución de la tecnología y los medios de comunicación, se ha modificado la concepción de educación (Aguerrondo, I. 2009); conocimiento (Amador, R. 2006) y aprendizaje (Hess, R. 2013). El lenguaje se ha especializado en la representación del conocimiento con una diversidad de formas gráficas, auditivas, simbólicas, movimiento y mixtas.

El hipertexto es una forma lingüística compleja al incluir una variedad de representaciones del conocimiento propiciando que el aprendizaje salga de las aulas de manera no lineal, personalizado y autónomo, extendiendo la organización educativa, no seriada en contenidos y transituacional (Rodríguez, J. L. 2004). El conocimiento se ha especializado cada vez más y el manejo de grandes cantidades de información, requiere nuevas formas de estructuración que simplifique, organice y comunique los contenidos de manera congruente y coherente (Novak, 1998).

La nueva organización y comunicación permite un aprendizaje asincrónico, autónomo requiriendo de un conocimiento especializado sobre algún tema y al estructurarlo necesita un lenguaje sintético, coherente y sistemático (Amador, R. 2006) que va desde el nivel referencial hasta el simbólico incluyendo toma de decisiones, conocimiento de los criterios y reglas al elegir temas, estrategias, formas y contenidos de aprendizaje llamado razonamiento (Kantor, 1978). El uso de mapas conceptuales permite construir estructuras conceptuales y la definición de éstas es más coherente, en comparación con el uso de representaciones en forma de texto (Novak, J. D., & Gowin, D. B. 1984). La comunicación razonada es necesaria para la identificación, diferenciación, generalización de conceptos y relación de los mismos. En la enseñanza de la psicología la representación con mapas conceptuales es relevante para precisar la información, considerando que existe una gran cantidad de conceptos polisémicos que se derivan de las diferentes aproximaciones teóricas (Guerrero, 2014).

El razonamiento es un proceso de construcción y comunicación del conocimiento, mediante mapas conceptuales es factible simplificar la información compleja mediante estructuras lógicas y por consiguiente, delimitar un sistema de conocimiento con formas diferentes dependiendo de cada contexto de información, intereses y preferencias temáticas. (Cañas, A. J. y cols. 2000).

Conclusiones: Los contenidos de los mapas conceptuales no se limitan a la lectura de documentos, requiere un conocimiento especializado sobre algún tema, donde para modificar, ampliar, añadir enlaces, entre distintos nodos, involucra razonamiento que puede ser individual o colaborativo si se encuentra en la Web (Landow, 1995), Los mapas, conceptuales facilitan la atención, comprensión, conocimiento, abstracción, aprendizaje, solución de problemas, razonamiento, en el contexto educativo (Novak, & Gowin, 1984)

CONCEPT MAPPING IN CONSTRUCTION MATERIALS TECHNOLOGY

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Abstract. Civil Engineering Science is a multidisciplinary type of science that requires enhanced understanding, integrated application of engineering, scientific, and mathematical principles. In particular, materials science is an interdisciplinary subject, spanning the physics and chemistry of matter, engineering applications, industrial manufacturing processes and environmental considerations such as climatic changes on a local or wider scale.

In the interdisciplinary approach, the differentiation of instruction permits the engineering students alternatives and opportunities to prepare their culminating reports in a variety of ways including writing reports in according to pc-lab exercises, organizing debates (e.g. timber products or aluminum alloys for windows frames), designing PowerPoint presentations and concept maps. In the context of the module “Constriction Materials Technology” in the program BSc (Hons) Civil Engineering and Construction (MC) of Mediterranean College, accredited by the University of Derby (UK), the module lecturer Mr. Kabitis I. chose to assess the understanding of the basis of materials properties for design applications within the construction sector through concept maps designed by student groups.

The selection of construction materials for a specific civil engineering application requires methodical, thorough, and imaginative thinking. The main idea behind concept mapping, as a meta-learning strategy in the frame of constructivism based on the Ausubel-Novak-Gowin theory of meaningful learning, is that thinking or understanding of material properties can be assessed by asking a student group to construct a cognitive (or concept) map by relating concepts or terms (such as creep, concrete, modulus of elasticity of the aggregate), in a hierarchical knowledge structure. For example, the creep, as one of the main mechanical properties of the concrete, depends on the modulus of elasticity of the aggregate, which is a major component of the concrete. In this example, the assignment tutor can assess the hierarchy levels of this proposition (e.g. aggregate as component of the concrete, creep strains as mechanical property), the cross-links (e.g. between the concepts “creep strains” and “modulus of elasticity”) and the linking words or phrases (e.g. “depends on”) that student group used constructing the concept map.

Two concept maps, constructed by two student groups of University of Derby (UK) in their Construction Materials Technology module, are presented. Each group chose a specific material (concrete, timber) and prepared a poster using the free software CmapTools which offers the ability to create concept maps, to share them using Internet technologies and to work collaboratively. Each group prepared a concept map for public and professional viewing encompassing raw materials, manufacture processes, the effect of moisture, temperature and other factors on the mechanical properties of the material, sustainability credentials and the laboratory tests. Both of the concept maps have a lot of concepts, branchings, examples and crosslinks and reveal students’ cognitive structure due to prior knowledge and current experiences provided by module learning events (e.g. slump test in the engineering lab of Mediterranean College). Students’ group consisted of three students Katakouzinos P., Ntasis G. and Zgherea Cr. chose to construct a concept map with major concept “concrete” and students’ group consisted of three students Palatsidi Efth., Vardalachos N. and Liveris-Tzelas T. chose to construct a concept map with major concept “timber.

CONCEPT MAPPING TEST AS A NEW DIAGNOSTIC TOOL FOR THE ASSESSMENT OF STUDENTS' COMPETENCES IN SCIENCE EDUCATION

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Abstract. In the context of a large-scale education policy reform project in Switzerland, educational standards based on competency models have been developed for grades 2, 6 and 9. A primary validation of these standards was part of the development process. As described elsewhere (Ramseier et al., 2012), some questions concerning validity and reliability of the performed tests remain open. To close this gap, we developed a detailed framework for the evaluation of one segment of the competency model: the competencies of "Ordering, Structuring and Modeling" (OSM) in the content domain of "structure and properties of matter". Based on this framework, which combines the concept of hierarchical complexity (Bernholt et al., 2011; Common et al., 1998) with a theoretical analysis of the competencies in the area of OSM, a computer- based Concept Map Test (CMT) has been developed and tested during 2014-2016. In addition to the CMT, students were administered corresponding Multiple Choice Test (MCT) in order to investigate the validity the results obtained through the Concept Map items. Teachers from Northwestern Switzerland (German speaking part) were selected as willing to test their classes on the Concept Map-Test giving 288 students in total in grade 8 and 9. Rasch Analysis was used to investigate instrument functioning and to determine linear measure of person abilities and item difficulties. Additionally, standardized tests were used to assess cognitive skills and reading comprehension. The results suggest that Concept Map items are in fact suitable to assess selected competencies of "Ordering, Structuring and Modeling" in the content domain of "structure and properties of matter", but some issues remain in terms of instrument development and improvement of fitting some items to our competency model. Since this research project is still in progress, the following questions will be addressed in presentation for discussion: 1) How does Concept Map Test compare to a classical Multiple Choice Test? 2) Is Concept Map task format as a diagnostic tool suitable for all students equally good?

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DEFINING THE NOTION OF CONCEPT MAPS 3.0

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Abstract. The aim of this poster is to present a proposal of how concept maps may be described, annotated and exposed on the Web of Data, also frequently known as the Semantic Web or Web 3.0. In doing so, the poster will first introduce the concept of concept maps 3.0 – that is, concept maps which utilize, and are enriched by, Web 3.0 technologies and resources. While concept maps 1.0 and 2.0 may be said to reflect earlier generations of the Web, the web of documents and the social web, the utilization of Web 3.0 technologies allows concept maps 3.0 to become machine-interpretable semantic web resources, and perhaps even semantic learning resources. This has several implications. One is that concept map discoverability can undoubtedly be improved through metadata annotation and the use of search engine interpretable vocabularies such as hts://schema.org/. Also, a key feature of Web 3.0 is that it supports integration of data, and that it makes it possible to identify "meaning" of concepts with unique URL identifiers. By employing an open data repository like Wikidata (https://www.wikidata.org), which provides identifiers for all entities contained in it, it becomes possible to uniquely identify concepts and concept types in a map as well as integrate data about these same concepts found in external semantic web resources that make use of the same Wikidata identifiers. These are just some of the interesting possibilities of concept maps 3.0. Another possibility is the ability to generate varied and dynamic visualizations of integrated data automatically.

The second key aim of this poster is to define the notion of concept maps 3.0 by adopting an existing set of recommendations for publishing data on the Web, namely the Web Data Principles (http://dret.github.io/webdata/) and transforming these into fundamental requirements for concept maps 3.0 as data sets. These fundamental requirements are 1) Concept maps should be linkable, that is accessible via persistent or stable identifiers. This obviously applies to the concept map as a whole but preferably also to its constituent parts. In this way, external resources can point to specific entities or objects in the structure. 2) Concept map distributions should be represented in open formats that do not require proprietary software for processing and whose source code is open to inspection. 3) Concept maps should be annotated by metadata using "well-known" and/or "well-documented" vocabularies. 4) Concept maps should be linked to other resources to enhance their informational or learning value. Links should be typed if possible to signal their communicational purpose and/or the nature of their target and to enable automatic processing. Individual concepts should be linked to external resources to better determine their identity. 5) Concept maps should be labeled with a license to signify when, where, how and by whom they may be put to use and under what circumstances. (Johnsen, L., & Jensen, J. (2016): "Towards Concept Maps 3.0 Visual Learning Designs as Web Data". Forthcoming)

Finally, the poster will provide simple code examples of how concept maps 3.0 might be marked up using the schema.org vocabulary.

DEVELOPMENT OF CONCEPT MAPS TO FACILITATE THERMODYNAMICS LEARNING WITHIN THE DEGREE IN CHEMISTRY

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In general, Chemistry is considered as a difficult subject for the students because its inherent concepts can be expressed at three different levels: Macroscopic, microscopic and representational (symbols, formula, etc.) (Johnstone, 1991). Thus, a significant assortment of problems in the learning of Chemistry has been well documented; from the most general ones related to the resolution of numerical exercises by the students (Pendley, Bertz & Novak, 1994) to other focused on particular topics of the Chemistry as Thermodynamics and Thermochemistry (Greenbowe & Meltzer, 2003), atomic structure, kinetics, etc. (Sirhan & Turk, 2007). Some of these topics concern the fundamental branch of Chemistry known as Physical Chemistry.

Thus, in order to facilitate the learning of the Physical Chemistry concepts within the context of the degree in Chemistry at University of Jaén (Spain), concept maps are being developed for the subject “Physical Chemistry I” that belongs to the second course (out of four) of the commented degree in Chemistry. This subject is devoted to Thermodynamics/Thermochemistry/Statistical Thermodynamics. It consists of ten lessons.

The present project involves two objectives. First, development of concept maps by the authors for the different lessons of the subject. Up to date, five concept maps have been built; the first of them intends to be a basic outline of Thermodynamics, the second gathers the fundamental concepts of Thermodynamics, the third is for the first Law of Thermodynamics, the fourth is devoted to Solutions and the fifth to Statistical Thermodynamics.

Second, implementation of the use of concept maps for “Physical Chemistry I” and its corresponding assessment. In this way, the program of the subject is divided in three blocks, one of them is taught/learnt using the concept maps developed by the authors as experts; for the next block the students are organized in several groups and a concept map to be constructed is assigned to each one; the third block is formed by lessons for which neither the experts’ maps nor students’ ones are used. The exam of the subject as well as the numerical exercises conducted during the teaching period can be used as tools for the assessment. In addition, a test focused on the concept maps has been delivered to the students.

The analysis of the current data has still to be carefully accomplished. The authors are aware that more effort has to be done to get a matured implementation of concept mapping for the target subject. Nowadays, the evaluation of the maps built by the students provides some interesting results since it has been observed that one of them contains rather correct contact linkers between concepts and other one involves right concepts.

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FACILITATING CURRICULAR ADAPTATION AND MEANINGFUL LEARNING TO STUDENTS AFFECTED BY RARE DISEASES (RD) USING THE SOFWTARE CMAPTOOLS

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Abstract. Rare diseases (RD) are those affecting at least 5 of 10,000 inhabitants. Many RD induce disabling conditions and those affected children in school age miss classes usually due to the complicated diagnostic and the several medical treatments they need, thereafter. The exact number of patients in this situation in Navarra (Spain) is still unknown, although it is expected that with the registration of RD launched in Navarra in 2012, a more adjusted number close to reality of school-age patients will be obtained. These students should be able to be identified in schools as the vast majority need curricular adaptations (CA). In this paper, the modeling of knowledge (MK) is proposed by using the CmapTools software, as a facilitator CA method. Thus, students affected by RD and who submit school truancy, could build their own knowledge and be evaluated in a more realistic and appropriate way according to the situations as diverse, they suffer in their school stage.

LEARNING FROM DOCUMENTS USING MULTIPLE VIEWS PRESENTED AS CONCEPT MAPS

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Abstract. Learning about a subject from multiple documents, either printed or in an online format can be taxing and confusing. Learning involves constructing a mental/cognitive representation about the information in the document and combining it with previous learner's knowledge representations. When it comes to study multiple documents, in addition to constructing representations for each document, an additional representation, a documents model, is constructed, describing interrelations among documents and the situations they describe. Consider studying an historical subject, where numerous documents are available and (nowadays) easily accessible. But how these resources should be accessed and in what sequence, in order to promote their study and to contribute to the development of integrated knowledge representations about the subject? The common method of presenting documents is to list them, as in a library catalogue. The list can be alphabetical by authors, or another sequencing mode, available in the interface. Each list is a view about a subject, based on some organizing principles, which can guide the learner's behavior. Generally, there are two classes of views: Metadata (e.g., author, publication, year) and Data (content aspects: title, key words, abstract, summary, outline, event list, etc.) views. An experienced learner, such as an expert historian, can use the available views, in the formats they are presented, in order to decide how to proceed with the documents, i.e., in what sequence to review them, what documents to compare and how. The expert is an autonomous learner, having available a learning management package developed from experience and evolved study methods. The novice student can be confused about the management of the learning situation. The student, and perhaps the seasoned learner, can benefit from a graphical presentation of available views, in order to reduce the cognitive load of the learning situation.

Consider, as an example, the Cmap describing the 7th International Conference on Concept Mapping (http://cmc.ihmc.us/). Some of the map nodes refer to documents (texts, maps, and web sites). The map's graphical layout presents a particular view about the conference, by guiding how to inspect the referred documents. A different layout may have produced a different inspection behavior. In our exploration study, we examined learning about an historical event, consisting of eight episodes, describing the blockade running of one of many ships carrying illegal immigrants from Europe to Palestine after the Second World War, which was then opposed by the British Government. The event was described in many documents, of which we selected ten. We mapped these documents by several aspects, each serving as a view about the documents and presented as a map or a list, using Cmap. The views presented (1) different genres: historical accounts, biographical accounts, journalism and poetry; (2) events chronology: which document mentions an episode; (3) Number of episods mentioned in a document; (4) bibliographic information about each document. The views were presented to first year education students as a list with adjacent study tasks: (1) write the story of the ship from two different points of views represented by different characters in the story; (2) Write about three contradictions found in the different documents. We compared the students' behavior and their tasks performance, with students who just receive a list of the ten documents for study.

LEARNING SCIENCE FROM DIGITAL TEXT WITH CONCEPT MAP DESIGN AND INTERNET IN HIGHER EDUCATION

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Abstract. During last decade digital books and also Internet are widely used in higher education. New technical devices like mobile computers and tablets have increased the potential of future learning materials which have a flexible format system and include dynamic media and links. Internet also offers plenty of learning materials in all kinds of formats and structures, like Wikipedia that students widely use for course–related research. It is often suggested that digital learning materials can be more flexible and attractive because of the dynamic features. But these dynamic features can also provide problems for students. Students easily "get lost" and are not able to read for understanding. However, previous studies have shown that students can gain a deeper understanding of the connections between the science concepts and principles when the concept maps are used in the digital learning materials. Based on the original idea of Novak and Gowin (1984) concept maps represent meaningful relationships among concepts and serve as a way to organize knowledge in an integrated manner. Concept maps can be seen as "a schematic summary" of ideas. According to Puntmabekar et al. (2007) there seems to be great potential to apply concept maps on digital text design because guidelines for designing effective hypertext are abstract and based mainly on common sense.

The purpose of this pilot study was to investigate how university students learn science topic, photosynthesis, by using digital text with concept map design or Internet. The hierarchical concept map was used as design principle of the digital text representing the main concepts connected to photosynthesis. The participants were 16 first year university students who had educational science as major subject. The study was realized with pre-and post-test design. The tests consisted of 13 statements, covering both facts and problem solving questions. The study had two phases with crossover design. First, participants were randomly assigned to either Internet or digital text environment. After immediate post-test the treatment was counterbalanced. The empirical phase lasted 70 minutes.

The results indicate that the digital text with concept map design supported more effectively science learning among higher education students than Internet. The order of the learning materials provided had an essential role. The student group which started with digital text material with the concept map design improved their learning more than the group which had first the Internet. Both groups learnt significantly better with digital concept map text design than with Internet. Furthermore, students better answered the statements requiring problem solving than the fact oriented questions in the concept map digital text treatment.

Finally, it can be suggested that digital text material using hierarchical concept map design can perhaps scaffold students in constructing relevant conceptual understanding better than open Internet sources in higher education. Therefore, concept maps may play an important role in developing future digital learning materials for enhancing learning also in higher education. Further randomized experimental studies assessing the impact of digital learning materials on student performance are needed.

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MAPAS CONCEITUAS: EXPERÊNCIAS DE AVALIAÇÃO E AUTO-AVALIAÇÃO NA PÓS-GRADUAÇÃO

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A sociedade atual requer formação profissional que estimule a colaboração e a inovação. E é nessa dimensão que identificamos no curso Ambientes de Aprendizagem Cooperativa Apoiados em Tecnologias da web, no Programa de Pós-graduação da Faculdade de Educação, da Universidade de São Paulo (FEUSP), na cidade de São Paulo (SP). A postura epistemológica socioconstrutivista como abordagem de ensino fez uso de metodologia provocativa com Mapas Conceituais (MC). Este trabalho resume o exercício metacognitivo acerca das experiências com MC construídos no curso. Os MC foram realizados em atividades colaborativas entre grupos de estudantes, para estudo e autoregulação (autopoiese) da aprendizagem. Foi usado o *software* Cmap Tools desenvolvido pelo Institute for Human & Machine Cognition (IHMC). Para um estudante de pós-graduação, as contribuições do MC revelaram nas representações efetuadas a Teoria da Aprendizagem Significativa de David Ausubel. O pensamento do mapeador enquanto estudante, direcionado por uma pergunta focal, organizado e representado graficamente, em redes, consolidou de forma significativa, os níveis representacional, conceitual e proposicional de suas aprendizagens. Ampliou-se o alcance das relações adequadas aos processos de diferenciação progressiva, reconciliação integrativa das hierarquias conceituais estudadas no curso (Novak & Cañas, 2010, p.10). O mapeamento conceitual estimulou padrões de aprendizagem mais significativos, que serviram de base ao pensamento reflexivo e criativo e contribuiu para hierarquização conceitual dos desafios identificados em suas pesquisas de doutorado (Novak & Cañas, 2010). A concepção de avaliação de Hoffmann (2001) que compreende o fenômeno avaliatório, a partir de Piaget & Vygostsky colocou em destaque a "reconstrução reflexiva". Os MC revelaram sua potencialidade significativa como organizadores prévios dos subsunçores pré-existentes para a trajetória das pesquisas em desenvolvimento dos estudantes que frequentaram o curso. Como bem destaca Piaget "a construção do conhecimento ocorre pelo processo de internalização da realidade captada pelo sujeito, que cria representações próprias, atribuindo sentido único ao que vivencia, tal qual uma espiral sem começo nem fim absolutos em termos de evolução do pensamento" (Hoffmann, 2001, p. 114). Os MC propiciaram formas inovadoras de avaliação como terreno fértil para abertura aos novos conhecimentos com maior sentido e significado; a consideração dos conteúdos prévios como ponto de partida ou subsunçores relevantes e pré-existentes; a flexibilidade e predisposição para aprender de forma não linear ou arbitrária; favorecendo a percepção das formas combinatórias das múltiplas representações de suas novas proposições do conhecimento. Como explicita Josso (2004), para as modalidades dessas experiências com os MC foram criadas oportunidades de ação reflexiva sobre as trajetórias dos estudantes. Estes representaram seus *designs* de pesquisa como um processo de metacognição permanente. A estratégia com MC associado à potencialidade dos organizadores prévios (conteúdos tecnológicos do CmapTools) favoreceram a reflexão sobre as regras básicas ao trabalho de pesquisa, ao trabalho cooperativo, a construção de sentido e significado na aprendizagem, sua organização, categorização e relações mais interdisciplinares de suas proposições. Os Mapas Conceituais contribuíram com o processo de autoavaliação de cada estudante na compreensão de suas atividades de pesquisa como combinatória de relações que favoreceram análise e reflexão sobre os temas estudados e objetivos das suas pesquisas.

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ORIENTAÇÃO DE TESES DE MESTRADO NO ENSINO SUPERIOR E DE TRABALHOS MONOGRÁFICOS NO ENSINO SECUNDÁRIO COM RECURSO A UM REGISTO DUAL: TEXTO E MAPA CONCEPTUAL

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Abstract. Na sequência do processo Bolonha verificou-se um reajuste do sistema Universitário Português. Concretamente, houve uma redução significativa das unidades curriculares bem como dos anos lectivos necessários para completar os diferentes graus. Num sistema Universitário com fortes carências em termos de preparação pedagógica dos docentes foi adicionado o problema da compressão curricular, comprometendo ainda mais a possibilidade de utilização de material promotor de aprendizagens significativas. Por outro lado, no ensino secundário as metas curriculares são muito exigentes e reduzem a disponibilidade de tempo para um ensino baseado no inquérito. Adicionalmente, é com enorme facilidade que os alunos podem aceder a informação, designadamente via internet e bases de dados científicas. Neste trabalho de investigação procurou-se aferir se a obrigatoriedade dos alunos de construírem os seus trabalhos monográficos em regime dual (texto e mapa), quer em contexto de ensino secundário com trabalhos monográficos de pesquisa anual, quer em contexto de ensino universitário, com Teses de Mestrado, permite promover aprendizagens mais profundas e significativas e se estimulam o desenvolvimento de competências cognitivas mais elevadas.

Para tal fim, foi proposto a alunos que estão a escrever as suas Teses de Mestrado e a alunos do ensino secundário que desenvolveram trabalhos monográficos de pesquisa anuais a seguinte proposta metodológica: realização e apresentação dos trabalhos em registo dual (texto e mapa para cada item do índice -submapa). Posteriormente os alunos realizaram um mapa síntese ou integrativo tendo por base todos os submapas. Seguidamente foi analisado o trabalho (texto e mapas) desenvolvido pelos alunos do ensino secundário e superior e foi efectuada uma comparação.

Foi possível concluir que o registo dual é um excelente método para a construção de um trabalho monográfico ou Tese, uma vez que a construção de um mapa para cada item do índice assegura uma adequada e progressiva compreensão e sistematização dos conceitos evitando-se uma mera evidência de conhecimento e/ou aprendizagem memorística. Por outro lado, a exigência dos alunos elaborarem uma mapa síntese permite a realização de reconciliações integrativas entre os conceitos dos vários submapas, assegurando dessa forma ao orientador/professor que os aluno aprenderam de forma significativa os conteúdos a avaliar, o que certamente será ainda mais perceptível na circunstância de existir uma apresentação e/ou exame oral. Assim sendo, será de todo o interesse permitir o contacto dos alunos com este tipo de proposta metodológica o mais cedo possível no ensino secundário, de forma a permitir um domínio otimizado da mesma, designadamente quando os alunos acederem ao ensino superior.

OS MAPAS CONCEPTUAIS E OS MOMENTOS FORMAIS DE AVALIAÇÃO: UM COMPROMISSO PARA O ENSINO SECUNDÁRIO ENTRE UMA TIPOLOGIA DE AVALIAÇÃO CLÁSSICA E A UTILIZAÇÃO DOS MAPAS CONCEPTUAIS

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Abstract. No ensino secundário Português existem várias disciplinas bianuais com exame final, designadamente a disciplina de Biologia e Geologia. O programa desta disciplina é extenso, tendo metas curriculares muito exigentes. Estes factos condicionam o processo de ensino-aprendizagem bem como o processo de avaliação. De facto, existe uma tipologia própria para a elaboração das questões do exame que condiciona o registo de avaliação em todo o ano curricular. Assim a maioria das questões são de resposta múltipla, verdadeiro e falso, ordenamento de afirmações e correspondências. Ainda que possam existir algumas questões de raciocínio e de comunicação científica a verdade é que as fichas de avaliação sumativas e os exames não permitem aferir com rigor o grau de desenvolvimento de competências cognitivas superiores. Neste sentido e tendo como enquadramento teórico a teoria de aprendizagem significativa de Ausubel e Novak (1986) procuramos desenvolver um compromisso que permitisse simultaneamente preparar momentos formais de avaliação e exames e promover aprendizagens significativas.

Para tal recorremos ao uso de mapas conceptuais como instrumento de diagnóstico dos saberes cognitivos prévios mas sobretudo como forma de demonstração do aluno face ao Professor da qualidade da sua preparação para o momento de avaliação e servindo também como suporte para eventuais questões orais. Neste sentido, os alunos construíram mapas conceptuais "demonstrativos do seu estudo" nos quais fizeram uma seleção de conceitos, construíram "grandes nós" conceptuais e integraram documentos em múltiplos formatos (diapositivos, texto, imagem, vídeo, páginas web).

Esta proposta metodológica permitiu aferir a qualidade e profundidade do estudo dos alunos na preparação para os momentos formais de avaliação através da inclusão no mapa conceptual de definições, resumos e questões de exame resolvidas. Estes mapas de "demonstração de estudo" são também um portfólio essencial para a preparação do exame de uma disciplina bianual. Os alunos também exploraram a possibilidade do CmapTools de gravar a construção do mapa bem como o diálogo formativo com o professor. Concretamente, os alunos reagiram aos comentários na forma de texto do professor, readaptando o seu mapa e permitindo dessa forma a construção de um "filme" que constitui um registo de "diálogo pedagógico individual".

O USO DE MAPAS CONCEITUAIS NA CONTEXTUALIZAÇÃO DO CONCEITO "MATERIAL DIDÁTICO": UM RELATO DE EXPERIÊNCIA NA FORMAÇÃO INICIAL DE PROFESSORES

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Abstract. Os materiais didáticos são elementos importantes para uma prática pedagógica eficaz, devendo ser trabalhados com os professores ainda em seu processo de formação inicial. Eles possuem várias características e funções pedagógicas, sendo necessário que os futuros professores possam percebê-las e considerar suas implicações para o ensino. Visando conhecer como os licenciandos compreendem essas características e funções, foram utilizados mapas conceituais em uma disciplina semestral de Produção de Material Didático, com 14 alunos do curso de Licenciatura em Física de uma universidade pública brasileira. A disciplina buscou apresentar e discutir tipos de materiais didáticos para o ensino de Física, bem como sua análise e produção, possibilitando aos licenciandos aptidão para analisar, desenvolver e utilizar diferentes materiais em suas ações docentes futuras.

As seguintes ações foram desenvolvidas na disciplina: seminários de pesquisadores convidados; leituras e apresentações de artigos científicos, por parte dos alunos; análise de materiais didáticos; elaboração de critérios para a produção e análise de materiais didáticos; e elaboração de mapas conceituais. Farão parte deste trabalho os dados coletados nas atividades relacionadas aos mapas conceituais, que envolveram: a) a elaboração dos mapas em duplas (7 no total), seguindo a orientação "Construa um mapa conceitual apresentando os conceitos discutidos na disciplina de Produção de Material Didático"; e b) respostas a um questionário aplicado ao final da elaboração dos mapas conceituais, sobre critérios para a escolha do conceito principal do mapa e contribuições do processo de construção do mapa para o entendimento dos conceitos da disciplina.

Dos sete mapas elaborados, seis apresentaram "material didático" como conceito principal, dentre as justificativas apresentadas destaca-se que este era: o tema principal da disciplina, foi o primeiro conteúdo abordado em sala de aula e era o conceito que possuía um maior número de possíveis relações. As médias de conceitos e proposições identificadas nos mapas foram de 14 e 17, respectivamente. Os mapas apresentaram diferentes conceitos abordados na disciplina, como: tipos de materiais didáticos, suas características, critérios para produção e análise e importância do material didático no contexto de sala de aula. Com relação às contribuições do processo de construção dos mapas conceituais para o entendimento dos conceitos abordados na disciplina, os licenciandos apontaram: a possibilidade de estabelecer relações e assimilar os conceitos; sintetizar o conteúdo abordado em aula; possibilitar a abstração dos conceitos; revisar, organizar e fixar o conteúdo; e tornar os conceitos mais claros. Embora a temática de materiais didáticos seja ampla e com diferentes implicações no processo de ensino-aprendizagem, o uso de mapas conceituais contribuiu para que os licenciandos pudessem compreendê-la, estabelecendo relações entre os conceitos por ela abrangidos. Além disso, os licenciandos se mostraram favoráveis ao uso do mapa na disciplina, pois perceberam suas contribuições para o entendimento dos conceitos, e também consideraram o uso futuro desta ferramenta em outros contextos.

PERSPECTIVA DE GÉNERO USANDO APRENDIZAJE SIGNIFICATIVO EN CARRERAS DE INGENIERÍA

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Abstract: En la actualidad la perspectiva de género ha generado mucha investigación alrededor de su visión, concepción y aplicación en diferentes ámbitos. En México el compromiso social es integrarlo de la forma más transparente y natural posible por lo que para estudios de ingeniería donde normalmente es un terreno dominado por varones es muy importante analizar y estudiar lo que ocurre.

Este trabajo presenta la propuesta de un plan de estudio que incluya la equidad de género e incorpore a la vez las ventajas y potencial del aprendizaje significativo que ya forma parte y se ha integrado en la docencia de varios profesores en la carrera de Ingeniería en Computación del IPN, México desde hace más de 4 años. El desarrollo y construcción de mapas conceptuales en el proceso de enseñanza aprendizaje favoreció a los estudiantes para desarrollar actividades dentro y fuera del salón de clases en donde se construyeron aspectos y realizaron observaciones en correspondencia con la equidad de género, así como, se generaron nuevas herramientas y materiales didácticos mediante perspectiva de género de forma transparente y con buena aceptación

STORYTELLING ABILITY OF PERSIAN-SPEAKING CHILDREN WITH CONCEPT MAP AND STORY GRAMMAR

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Abstract. Storytelling is an effective method to enhance children's learning level, because it compels children to create meaning based on their observations and experiences. Using concept map provides graphical tools for organizing and representing children's stories so it can help them creating more innovative stories. Learning story grammar also, improves children's knowledge about storytelling. The main objective of this study was to evaluate the effect of concept map and story grammar on storytelling ability of Persian-speaking children in two age groups. We examined 14 Persian children with the age ranges of 7-8 and 8-9 year olds. Children took part in story-telling experiment in which they tell story and draw their concept map on a piece of paper. Findings revealed that although Persian-speaking children in the older age group used story grammar features (time and place of the story event, the main character of the story, events and their sequences) and Concept map in their storytelling more and more precisely and their stories are more complex, but these differences in their performance were not significant between the two age groups. This study provides strong evidence that the concept map and story grammar can improve children's storytelling ability. All story events and characters that are enclosed in circles and the relationships between them encourage children to tell their story with more details.

Keywords: concept map, story grammar, child storytelling, child language

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