Concept Maps: Making Learning Meaningful
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USING CONCEPT MAPS AS A SYNTHESIS TOOL TO CONSTRUCT INTEGRATED CURRICULUM

Evandro Cantú; Nilva Schroeder; Divina Z. P. da Silva , Instituto Federal de Santa Catarina, Campus São José, Brasil

Email: cantu@ifsc.edu.br; nilva@ifsc.edu.br; divina@ifsc.edu.br

Abstract. In this work we present the use of concept maps during the construction of integrated curriculums, facilitating teachers dialogue and fostering the understanding of the intricate relations between each element that must be considered to construct a curriculum. We describe our experience in curriculum design during the last years at Federal Institute of Santa Catarina, in Brazil.

1 Introduction

This paper presents the use of concept maps as a synthesis tool during the collaborative work to construct integrated curriculum at Federal Institute of Santa Catarina, in south of Brazil.

The concept maps are a kind of "graph" used to represent the relationships among a group of concepts. The concept maps were developed by Novak in the sequence of studies on meaningful learning model (Novak & Cañas, 2006). In the concept map representation, concepts can be represented in a hierarchical way with the most general and inclusive concepts at the top and the more specific ones organized hierarchically in the bottom. For a concept corresponding to a node, it is also possible to build another concept map with the objective of refining it.

The use of concept maps has increased during last years, in particular on educational activities. One common use of concept maps is to organize and structure the knowledge, for example in curriculum planning, showing the relationship between different parts of the course. With this organization of contents is possible to identify the general concepts prior to instruction and assisting in the sequencing of learning in a progressive way, from general to more specific and explicit knowledge (Novak & Cañas, 2006).

In this work, the concept maps were not only utilized to present the contents organization. They were used as a powerful collaborative and synthesis tool in each step of curriculum construction. We used concept maps to synthesize educational and legal documents about curriculum, facilitating the understanding and the discussion between the members of work group. We used concept maps to synthesize ideas during collective debates. We used concept maps to show innovative ideas incorporated in an integrated curriculum. Finally, we also used the concept maps to organize knowledge in each curricular unit.

As applications examples, we describe four different experiences in curriculum planning realized during the last years at Federal Institute of Santa Catarina, evolving different modalities of courses.

2 Concept Maps Applied to Organize Knowledge in a Curriculum Planning

The use of concept maps has been unproved in the last years at Federal Institute of Santa Catarina. The first experience was managed in 2005. In this year the concept maps were used to model a complete technical course for adult education in the area of refrigeration and air conditioning.

To start the process, we presented the meaningful learning model and we realized some workshops about con-

* All concept maps presented in this paper were translated from the original wrote in Portuguese.

cept maps with the teachers involved in the course planning. In the second step, a global concept map, describing the "scope of formation", was constructed in a collaborative manner and discussed by teachers and people of pedagogical support. The Figure 1 shows a concept map* that represent the scope of formation of the course of refrigeration and air conditioning.

Looking and referencing the global map describing the scope of formation, each teacher constructed a concept map of his specific discipline. Teachers of fundamental areas, like physics, mathematics and humanities also worked in this activity. Finally, all the concept maps were presented, discussed and modified by the group of teachers. The Figure 2 shows a concept map representing the knowledge organization of the HAVC (Heating, Ventilating and Air Conditioning) Design discipline, constructed by the a teacher of technical area of refrigeration and air conditioning.

In this application, the concept maps allowed a global view of the technological course and showed explicitly the relation between different disciplines involved in the educational process. The common points of these disciplines could be clearly observed by teachers, avoiding the superposition of contents and the omission of important ideas.

The concept maps also create a link that facilitated the communication among teachers. In each discipline, the concept maps also helped teachers to organize their modules and put in sequence the contents to be taught, according the meaningful learning model.

The set of concept maps were systematized and published on the web, forming a reference to the course development.

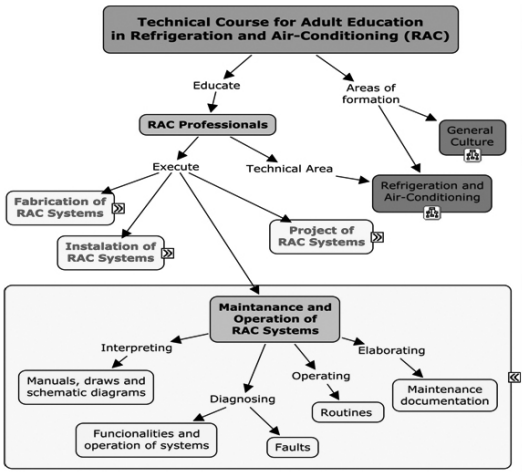

Figure 1. The scope of formation in the course of refrigeration and air-conditioning

3 Concept Maps Used as a Synthesis Tool to Construct an Integrated Curriculum

The second great experience in the use of concept maps in curriculum planning was during the design of a course to licentiate teachers in chemistry and physics.

The Federal Institutes are a traditional net of technical schools in Brazil, offering technical courses from basic to graduate level. The courses to licentiate teachers are a new modality of education that were recently incorporated to the Federal Institutes responsibilities with aim to decrease the lack of science teachers for basic education in Brazil (Brasil, 2008).

To construct a curriculum for this new modality of education was a great challenge to teachers of Federal Institute of Santa Catarina. To better prepare the group of teachers involved in the curriculum planning, the work initiated with formative activities in many areas related to curriculum and legal aspects of a course to licentiate teachers in science education. The first formative activity was about "epistemology" and "history of science", as tools to help the interdisciplinary studies in science education. We also discussed the use of "research as a formative tool" to improve

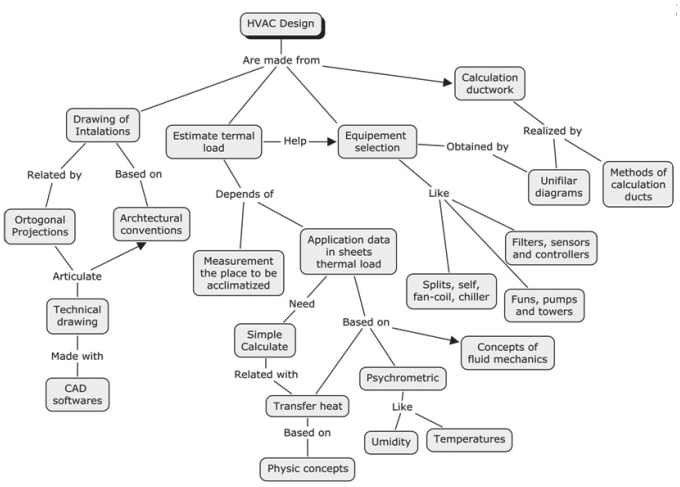

Figure 2. The concept maps representing the knowledge organization of the HAVC (Heating, Ventilating and Air Conditioning) Design discipline (Elaborate by teacher Jesué Graciliano da Silva)

learning and the relations between "practices and theory" in science courses (Chassot, 2008). In the second formative activity we discussed the Brazilian governmental polices to licentiate teachers and other legal aspects of this modality of education (Freitas, 2007; Machado, 2007). About curriculum planning we discussed the concept of "integrated curriculum" and we also realized some workshops about the use of concept maps in educational activities and curricular planning (Novak & Cañas, 2006; Cantú et all, 2004; Cantú & Farines, 2007).

During these formative activities, the concept maps were used to synthesize documents and ideas under study. We highlight that concept maps helped in documents understanding, showing the main elements in study, and facilitated discussion of subjects among people involved in the work group. An extensive set of concept maps were constructed and published on the web. Some concept maps were utilized in the pedagogic project of course and they constitute a base for consult and studies about the ideas used to uphold the curriculum. After these formative activities, we started the construction of the "professional profile" of the course to licentiate teachers of science. We realized many meetings and we used concept maps to model and organize the ideas under discussion. Using a multimedia projector and CmapTools*, the concept maps were constructed and discussed on line by the group of teachers. After each meeting, the concept maps were refined, systematized and published on the web, facilitating the feedback and preparing the next discussion. The Figure 3 shows a concept maps representing the professional profile of the course to licentiate teachers in science.

In the next step of curricular design, the work group began to construct the "curricular matrix" working in a collaborative manner. With a "free interpretation" of concept maps, many new educational ideas were incorporated in our "curricular matrix", which does not seem a traditional one, as is show in the Figure 4.

The left side of Figure 4 shows the three "thematic moments" that were divided the course. The first moment, in the two first semesters of the course, the theme is "to problematize the relationship between the student and school and the student and science". The second thematic moment, during the third and fourth semesters of course, is "study the possibilities of transform and improve the process of education". The last thematic moment, during the last four semesters, is dedicated "to make interventions on the pedagogic reality".

For each semester, a "core problem" was chosen to integrate the curricular units, as the right side of Figure 4

* Informations about CmapTools can be obtained at http://cmap.ihmc.us.

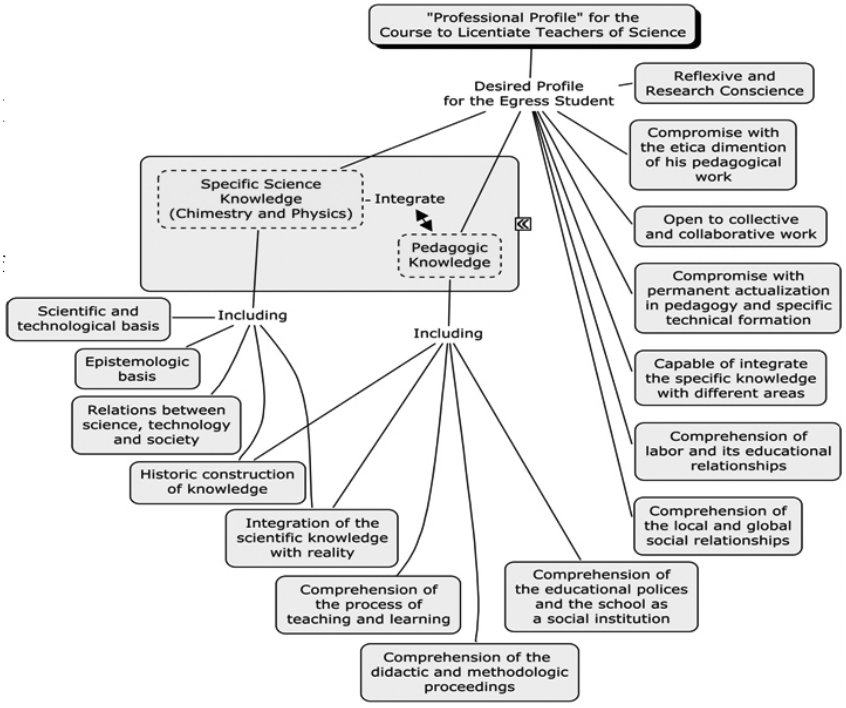

Figure 3. The desired profile of the egress of the course to licentiate teachers in science

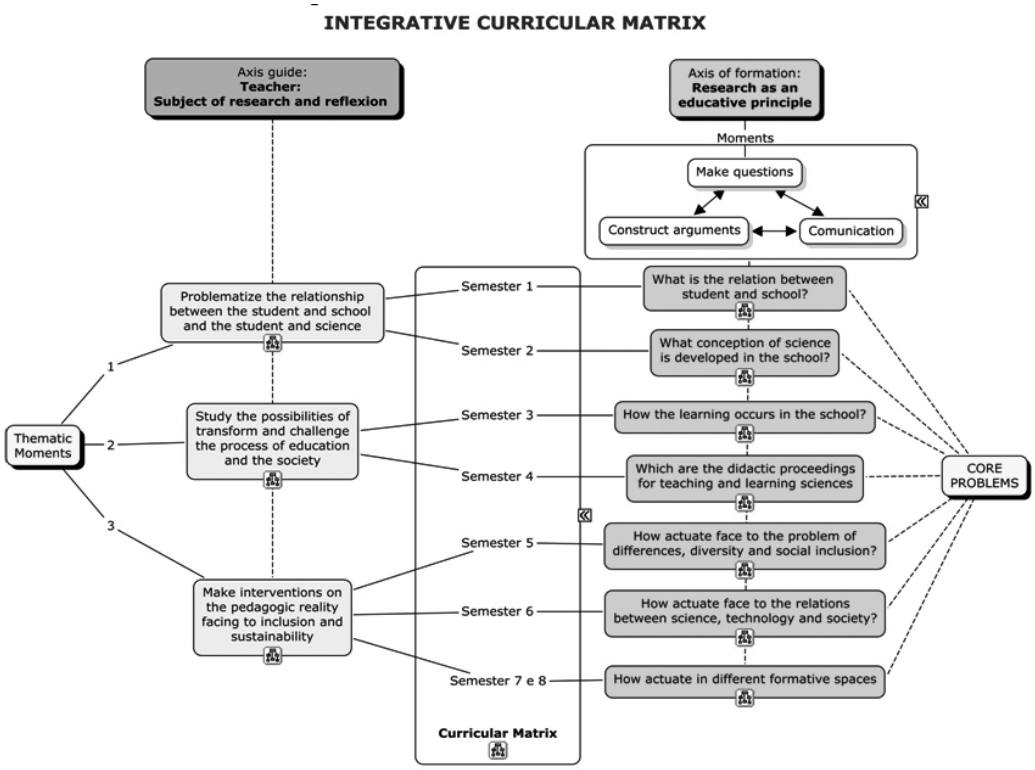

Figure 4. The curricular matrix of the course to graduate teachers

shows. These core problems are utilized as central questions in “integrator projects”, “professional stages” and “final

The Figure 5 shows the curricular units that form the first semester of the course. The “core problem” of this semester is developed through an Integrator Project, which integrate the curricular units of this semester. The teacher of each curricular unit must “answer the questions”, show at the right side of Figure 5, as a form of collaborate in the Integrator Project of the semester. Working this way, all teachers evolved in the curricular implementation know how to collaborate with others teachers in order to realize an integrated work. The curricular units other semester are organized of similar way and also modeled by concept maps.

All this educational ideas were modeled with concept maps, which were constructed on line by the group of teachers along many meetings using the CmapTools. These maps are now published on the web and support the implementation of the course to licentiate teachers.

4 Concept Maps: A Reference Tool to Manage a Collaborative Work

After these successful experiences of using concept maps in curriculum planing, described in the two previous sections, our academic community took the concept maps as a reference tool to manage collaborative work.

Recently, we used the concept maps to manage the collaborative work during two others curriculums planning. In the first work, we used the concept maps as a synthesis tool during the construction of a curriculum for a new modality of technical course for young people, integrating the studies of secondary school with a technical formation. In this work, we managed a group of 20 teachers, including teachers of technical domain and fundamental areas, like mathematics, physics, languages and humanities. Here we used the concept maps to synthesize documents and to represent the common ideas under discussion. The final project of the course included many concept maps used to represent the curriculum organization and key ideas.

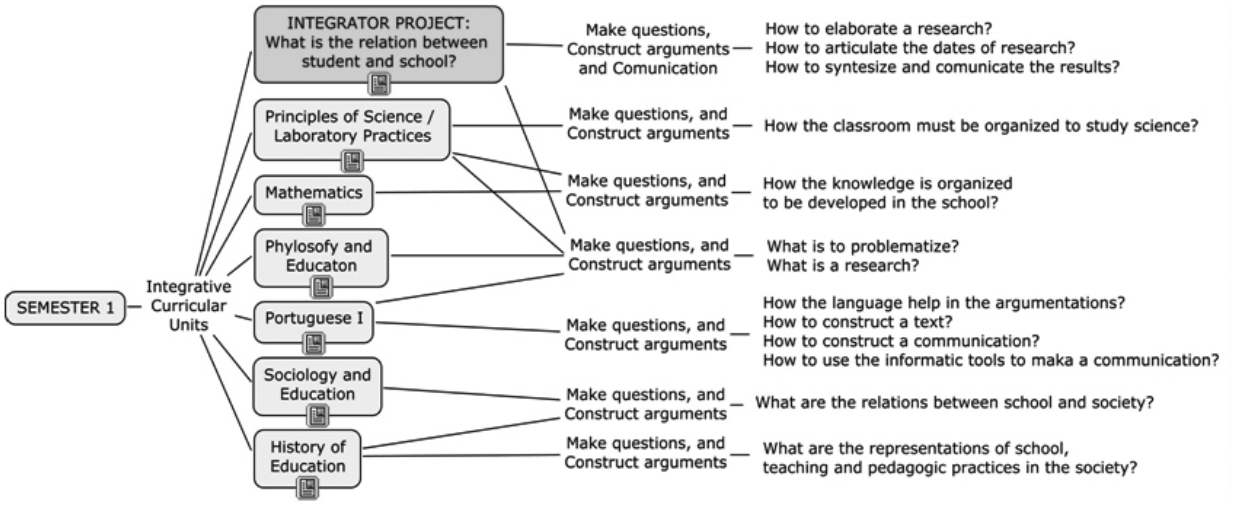

Figure 5. The desired profile of egress of the course to licentiate teachers

The last work is under construction, in which we are planning a curriculum for telecommunication engineering. The engineering courses are also a new modality of education that was recent incorporated in Federal Institutes responsibilities with the aim of improve the Brazilian development and decrease the social differences in Brazilian society. In the same way, we are using the concept maps as a synthesis tool during the collaborative works. Many documents with polices and principles for engineering courses for the Brazilian reality were modeled by concept maps and are published on the web. The Figure 6 shows one of a set of concept map constructed to represent the guiding principles of engineering courses at Federal Institutes (Brasil, 2009). These concept maps facilitate the understanding and the exchange of ideas among people involved in the curricular design for engineering. We highlight that people of different Campus of Federal Institute of Santa Catarina are using these concept maps to better understand the polices

and principles for engineering courses.

The "professional profile" of the course of telecommunication engineering is also been constructed with the help of concept maps. The profile includes many humanistic competences which will be develop during the course using "integrator projects" and "problem solving" strategies turned to solve social problem of the Brazilian society. All these ideas are under construction and we believe that concept maps will be a great help to construct the final curriculum.

5 Final Considerations and Perspectives

The experience of using concept maps as a synthesis tool during curriculum planning, makes us confirm some convictions about education and collaborative work.

First, the collaborative work is imperative to produce any pedagogic innovation and concept maps actuate to improve these innovations representing clearly the ideas under construction, encouraging the emergence of new ideas and facilitating the share of knowledge among people working together.

Second, the continuing education is fundamental to construct the personality of the educator. When people of different formations and open mind work together to accomplish some objectives many possibilities emerge and the work becomes a space of formation. Sharing knowledge and using a new tool, as the concept maps, the educators learn and improve his/her professional skills.

Last, as Novak and Cañas (2004) assert, the concept maps and the associated tools connected to Internet create a new model of education, putting in practice many educational ideas that were difficult to implement other way. Beyond the use of concept maps to improve the students teaching and learning, we emphasize the power of this tool to help teachers and coordinators to improve the educational activities, like the curriculum planning activities described in this paper.

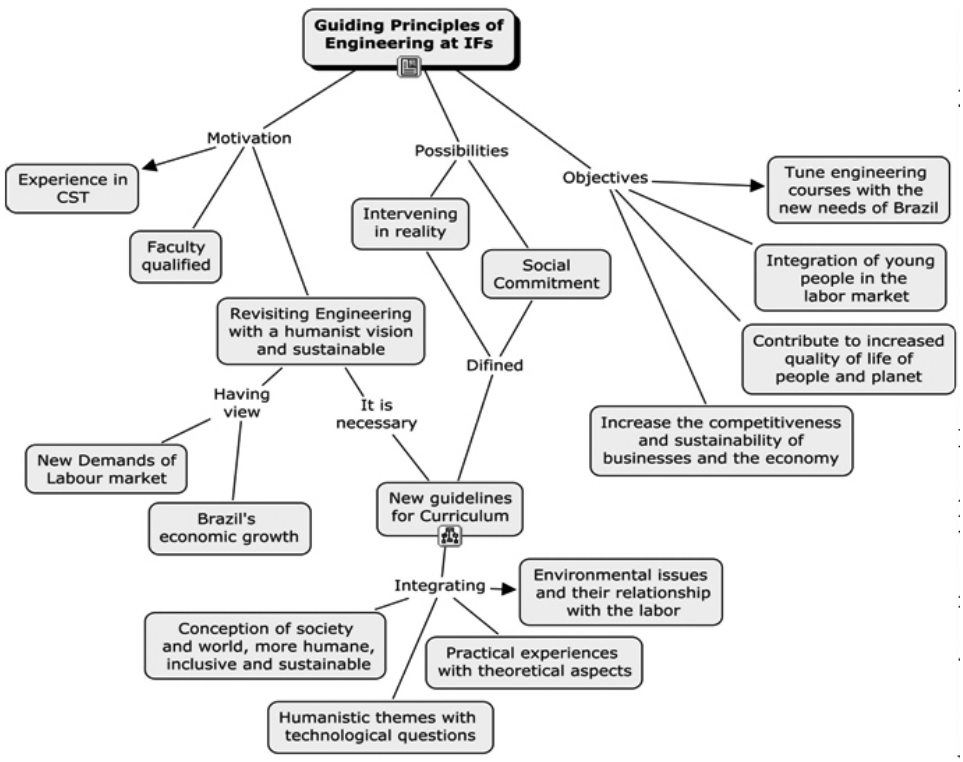

Figure 6. Guiding principles for engineering courses at Federal Institutes

6 Summary

In this article, we presented the use of concept maps as a synthesis tool during the collaborative work to construct integrated curriculum. We describe four experiences in curriculum design during the last years at Federal Institute of Santa Catarina, Brazil. In the first experience, the concept maps were used to describe the profile of course and to organize the knowledge in each discipline. In the other experiences, the concept maps were used as a synthesis tool during all phases of curriculum planning, to synthesize texts and documents, to organize and to share ideas and to model the final curriculum.

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