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AWARENESS FROM THE BEGINNING

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Abstract. Concept mapping can be used to summarize and organize a complex progression of propositions. Meaningfulness of these propositions, as results after self-evaluation or by questioning the individual concept-mappers learners, cannot be given for granted. Neither this result should be necessarily obtained by working to the construction of a concept map from the beginning and constraining all representations and narratives into a concept map format. Because the process of becoming aware of new meanings can be better achieved through activities that are different from concept mapping, in which serial processes of oral or written language transformation can be favorably used, concept mapping can be applied as a refining and consolidating strategy, and as a tool to design holistic structures for helping global understanding, only after the most challenging meanings have been internalized, exemplified and are accessible to consciousness. This paper is about how to make students more and more consciously aware of new meanings, relations and scientific concepts by integrating several practices and concept mapping.

1 Introduction

In describing his theory of human comprehension, Walter Kintsch (1998) affirms that:

«Knowledge is primarily stored in the world, not in the individual brain. Biological memory carries around the code for the use of external memory, whereas the specifics are found in external symbolic storage systems. Pedagogy has always been directed at this abstract level. This is where learning problems arise and where most special instructional efforts are needed. This is what school learning is about.» (p. 18)

This is true and has two important consequences. The first is that knowledge is neither stored in the teacher's brain indeed; so, every time you face a new group of students, you have to invent and tailor new suitable strategies to approach them to the syllabus and vice versa. Secondly you realize that school teacher's pedagogy is left the "dirty job" that justifies *every* strategy to make pieces of real knowledge available to the students' consciousness, as well as to your consciousness.

As shown by the title, this paper reviews special instructional strategies - that were applied to secondary school teaching of *organic chemistry*, and are even (wishfully) transferrable in other contexts - aimed to drive students to become aware of their previous and new knowledge.

During recent calm and profound discussions about their previous learning experiences, my beginners students of chemistry reported to me their sensation as of: "continuously flowing familiar 'things', that we were told, we knew, we said or we did, time by time, and that we recognized as the stuff belonging to that teacher." I suspect that "that teacher" remained the only "stimulus" that *was* able to re-evoke some mechanical action or knowledge from those students. Further discussion revealed that nobody was casting for doubts or questioning for real understanding. The worst issue in this –unfortunately- widespread atmosphere, is the unattainability of the *individual sense of cognitive achievement*, the most important source of motivation that was traded for grades. On the other side, these low levels of awareness and integration in the flow of information, seriously hinder any chance of gathering a deep understanding of any subject (Tifi, 2010).

A shift is needed from "what you learn is what you practice and repeat" to "what you learn is what you verbalize consciously", because verbalizing is choosing, contextualizing, comparing, generalizing, evaluating, criticizing, transferring and applying to solve problems.

These high order cognitive operations, as shaping general cognitive & affective apprenticeship (learning how to learn & feeling capable to understand and learn) cannot be straightforwardly taught. They accompany internal and external language development as long as increasing awareness of oneself changing knowledge is scaffolded by multiple verbalization of insights: transformation of language from narrative to propositional argumentation, from L2 to L1 ("code switching" in CLIL methodology), from textual to other figurate, visual and sensorial modalities and vice-versa.

2 The Speaking/Thinking System of Meaning

Educational strategies based on practical training or "learning by doing" overlook the role of consciousness and consider awareness just a special feature owned by a few exceptional students. Not enough concern is given to

the qualitative development or delays in the *structures of generalization* and to the qualitative changes of the *Speaking-Thinking System*, described as a unity by Vygotsky in his latest writings, and recently re-appreciated by Holbrook Mahn's analysis *Speaking/Thinking System of Meaning* (Mahn, 2012). A concept map relying on Mahn's analysis is available online for details (Tifi, 2012). Some theoretical aspects of the System of Meaning and of its development are particularly important and can be summarized here.

Thinking in concepts is a goal that can be achieved after transformation processes "*from direct, innate, natural forms and methods of behavior to mediated, artificial mental functions that develop in the process of cultural development*" (Vygotsky 1998, p. 168, italics in original). The higher psychological processes depend on new mechanisms that result not from the gradual, linear development of the elementary processes, but from "a qualitatively new mental formation [that] develops according to completely special laws subject to completely different patterns" (Vygotsky 1998, p. 34) The formation of which Vygotsky talks about is the Conceptual System of Meaning and the "special laws and patterns" accompany the shaping of word meaning and the development of structures of generalization. These laws and patterns consist in the "specialization" and differentiation of meaning from words, in *bottom up processes* where everyday and spontaneous concepts are brought up to consciousness, can be put in relation to scientific concepts, in that special kind of interface or "word-gym" that is called Zone of Proximal Development (ZPD), and are characterized by the use of generalizations to make more abstract new meanings. The following quote makes clear that word (speech) and meaning (thinking) undergo different development trajectories in the system of Speaking/Thinking:

"From primitive generalisations, verbal thought rises to the most abstract concepts. It is not merely the content of a word that changes, but the way in which reality is generalised and reflected in a word".

This generalization is highly subjective, flowing, often undefined or contradictory, and worthy to be challenged by acting in the ZPD even if there are always going to be degrees of divergence between sociocultural meanings and the sense of words or concepts incorporated into an individual's system of meaning (Mahn, 2012). There is an apparent contradiction in propounding a "good learning that is in advance of development (Vygotsky Mind in Society, p. 89)" and recognizing that "*Consciousness and control appear only at a late stage in the development of a function, after it has been used and practiced unconsciously and spontaneously*. (Vygotsky, Thought and Language, p.90)"

Bruner (1986) describes his profound experience and research on tutoring in the ZPD admitting that that task would be bound initially to be unconscious and unreflective, but good learning could be equally feasible thanks to an implanting or "lending" of vicarious consciousness, that is *scaffolding*. Tutoring in the ZPD (scaffolding) puts into practice several means to be "conscious for two": to control the focus of attention, to dramatize the presentation, to use metaphors, to demonstrate that a task is possible, to manage common foresight of coming steps and segmenting the task to appropriate complexity, help to recognize a pattern or the solution, hand over parts of the task to the learner, ask to rename and rephrase, compare and make narratives of what's going on. All these actions can be accomplished, availing of language transactions, even if the "learners could neither do it on his own, nor follow the solution when it was simply *told* to him" (Bruner, 1986, chap. 5).

It should be evident, from this basis, that concept mapping can be only one of several tools to help this scaffolding, and one of the most abstract, if we mean concept mapping as dealing with external, objective meanings and propositional-hierarchical argumentation.

It is possible and important that, in adolescent and post adolescent age, experience in conscious - conceptual thinking would be *prepared* in scaffolded modality, even if abstract generalization, as required in problem solving, remain mostly inaccessible to the learner. In this way school education can *prepare* the higher order thinking skills in disciplinary study, but it is with older students (16-), who are entering the stage of autonomous conceptual thinking, that the activities presented in this article would be more effective in shaping the system of concepts.

3 Creating a dialogic and modifying environment

To open the space of dialogue and the meaning of the ZPD beyond cognitive scaffolding (Wegerif, 2007), to engage students in collective or peer discussions, with collaborative stages and written tasks to expand meanings, is yet a difficult target, because learners are accustomed to the "passing away" mode due to their habits, generated in a predominance of traditional classes. The expectation of direct transfer of knowledge from instruction of what-has-to-be-done (that is called "explanation" by these students) makes them skeptical on the

need of more discussion, reflection or writing more about a topic, after the content has been "communicated". To the sake of establishing a constructive environment from this climate, it is strictly necessary to impress a rhythm and to schedule the tasks not relying on spontaneous participation or continuous individuals' prompting, but following pre-thought flexible plans. This will save class time too. Direct opposition to passive stance is a losing game. In the development of the mainframe there are lots of occasions of spontaneous students' utterances to focus on, feedback and rephrasing that can be given back to them, narratives that can be stimulated, and that the beginner learners could not be able to unfold by themselves. In this context also the most inert learner will find some insights, disclosing his "perhezivanie"[1], that is the starting point of awareness.

3.1 Word confidence by construction of narratives

Spontaneous usage of scientific words indicates that probing of scientific meanings has started. There are several oral and written exercises leading to word-confidence. From oral recounting by using a word bank on the blackboard, to a common cloze exercise. A text can be written using everyday concepts that replace the scientific concepts which will be restored by pairs or groups of learner (Fig. 1). The opposite requirement (identify scientific concepts and replace them with everyday concepts) could be useful in a earlier stage, whereas the task of conforming a mingled text with interspersed informal, formal and some incorrect statements, could be an assignment for a more advanced stage.

Introduction: reactions in which a molecule is summed up to an organic molecule
A substance whose molecules contain a multiple bond between two carbon atoms, can be transformed in a substance without such bonds. In the transformation, disappearing of multiple bonds will be accompanied by the sum – to the two carbon atoms of that bond – of two atoms or groups deriving from an external substance that is added in the transformation. Possible "external molecules" that can be summed to the organic substance are: molecules of dihydrogen, molecules formed by two halogen atoms, molecules formed by an hydrogen atom and an halogen atom, water molecules. Starting from a molecule with a double bond between two carbons, in first case we would obtain a final organic substance without such double bond; in second case we would get a molecule with two adjacent halogen atoms, in third case we would get a single halogen atom in the resulting molecule and, in fourth case, we would obtain a molecule formed by an oxygen atom bound to a hydrogen atom and to a carbon atom…

Introduction: addition reactions
An **unsaturated substance** can be transformed in a **saturated substance**. In the transformation, disappearing of multiple bonds will be accompanied by the **addition** – to the two carbon atoms of at **pi-bond** – of two atoms or groups deriving from the **reactant**. Possible **reactant molecules** that can be **added** to the organic substance are: dihydrogen, halogens, halogenhydric acids, water. Starting from an **alkene**, in first case we would obtain an **alkane**; in second case we would get an **1,2 dihaloalkane**, in third case we would get a **mono-haloalkane** and in fourth case, we would obtain an **alcohol**…

Figure 1. Elicitation of scientific concepts: the upper text contains a small part (intro) of the original text about electrophilic addition reaction. Two students worked out the bold concepts (lower, halved text) demonstrating a good confidence with those scientific words.

Unexpectedly, this task was mastered very differently by the different students in the same class. After a preliminary analysis I can say that this is at least partially due to the habit to use symbols (formulas) instead of word-labels for concepts. This is evident in normal talk on chemical topics too. The facility to identify the correct substitutive words for "hydrogen atom without electron" resulted very reduced if students was used to tell symbol labels as "aitch plus" (H^+) instead of "(hydrogen) ion" or "proton" *word-labels*. These are indeed *different forms of generalization* and reveal very different degrees of confidence, connection to reality and understanding of the basic concepts of general chemistry. The main problem I had to face with firstly was a kind of cognitive and consequent emotional block, that hinders the process of "mining" of spontaneous concepts. This was the reason to develop the following easier activity that succeeded to overcome the block and to reactivate the spontaneous "logos" from bottom-up.

How do you would explain (something) to a young former student? Individual (16 y) learners had to write a short explanation about "how would you explain to a thirteen ager how a bond between two atoms can be formed or broken?" That was followed by a pair re-writing session and then by a new session where groups of four merged their ideas in the most "convincing" explanation. A speaker was sorted out for each group to simulate the explanation that was delivered to another teacher. Students tend to overlook and underuse their everyday concepts to represent and make sense of more complex events, and this experiment, as the next in Fig. 2, were valuable to restore this kind of self-effectiveness, to enhance word confidence i.e. to make spontaneous concepts closer to the scientific ones.

As pointed out by Kandiko & Hay (2010) concept as ideas (meanings) and narratives are inseparable in the process of arising understanding as insights. This simply overthrow concept mapping as an elective strategy.

[1] This term was used by Vygotsky to express the wholeness of psychological development stages that are signed by the integration of cognitive & affective, internal & external elements that lead to a completely positive emotional experience.

April 13rd - Plots from the microscopic world
Chemical reactions are acted, as we know, by strange "characters" devoid of intentions. Sometimes we ascribe to them human features as "aggressiveness", the "will" or "desire" to form **covalent** bonds with **species** with **unpaired** electrons (free radicals), or we assign "peace of senses" to stable species or the "willing" to complete the **octect** to those species that don't reach that configuration. We attribute certain "preferences" to species, as to bromine, which would "prefer" the **substitution** to tertiary hydrogens, while chlorine has less marked **selectivity**. But we know that molecules, atoms, ions, radicals, i.e. all **species** that populate the submicroscopic stage, are not blessed of such "feelings", because their behavior is the consequence of reciprocal random **collisions** and of **structures** assembled mainly by weak or strong covalent bonds, characterized by high or low **energy**.

Figure 2. Cloze exercise in which scientific words to fill in blanks are shown. These terms are inserted in a narrative-metaphoric context.

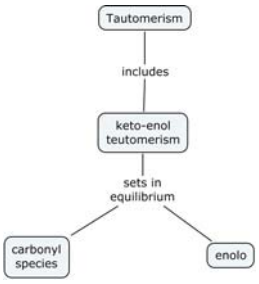
Example A, March, 15th, 3rd grade
Chromatography is a general term for a **separation** technique that exploits **differences in affinity** for both the **stationary** and **mobile phases** of the several substances in the **mixture** that must be separated.

Expansion as glossary, observation of objects, demonstration and group lab practice experiment, videos
mobile phase: it is the carrier fluid (a gas in gaschromatography, an instrumental technique, liquid in column chromatography, in TLC, in HPLC = High Pressure-Performance Liquid Chromatography). The mobile phase is called **eluant** in liquid chromatography and **carrier gas** in gas chromatography.

stationary phase: is a bonded or immobilized stable phase that holds back the molecules dragged by the mobile phase. It can be an insoluble, inert, solid or high-boiling liquid…

Example B, March, 25th 4th grade
Carbonyl compounds show a body of transformations that are due to the slight **acidity** and **mobility** of the **alpha hydrogen** (if present) and **carbanion-like** behavior of their **alpha carbon** atom.
Mobility of the alpha hydrogen, from alpha carbon to the carbonyl oxygen, is (a sub-case of) an acid-base-catalyzed equilibrium reaction, among two **tautomeric** species or **tautomers** that are (- in this case -) the carbonyl molecule and the **enol** molecule. This **equilibrium** occurs in water solution.

Expansion through examples, energy calculation, equilibrium mechanisms drawing and individual concept maps:



"Seed" Cmap

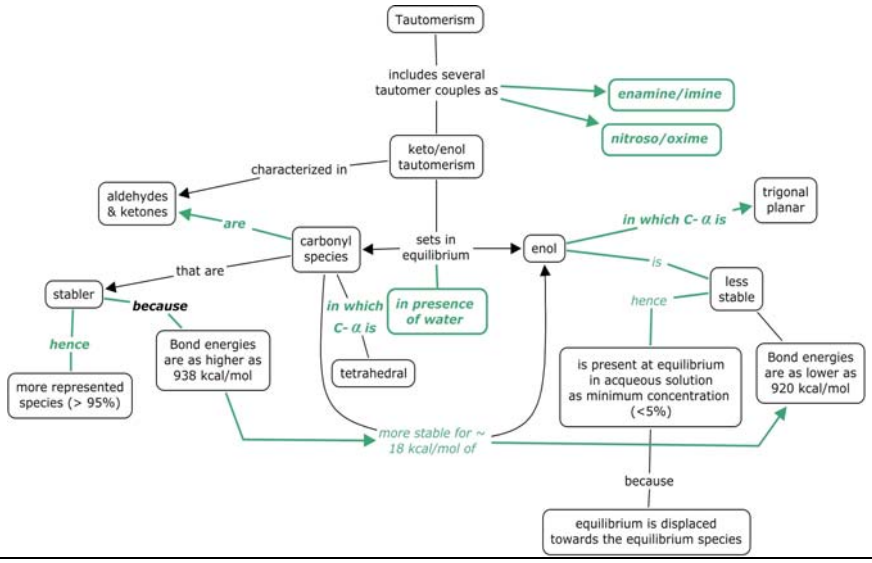


Figure 3. These two examples of "expansion text" were presented to start new topics in two different classes, in English language (blended CLIL lesson). The concepts were highlighted during the discussion. The phrase (- in this case -) was put in brackets because the connected complexity was delayed to a second discussion. Concept mapping (example by L.M. In Example 3) was the last step in this introduction.

Satisfactory class dialogue outcomes resulted in the experiment of starting a topic with a very dense and concise text containing the most important concepts of the new topic, as in Examples A, B. (Fig. 3). After a few time the problem in example A was faced, the whole sentence was mastered by everybody – but only as word level and of syntax coherence. The magic happened soon: a student wanted to know "how affinity works". He *claimed a deep understanding*, asking expressly for a possibly scientific definition for "affinity". From that moment it was possible to expand the topic by creating narratives, examples, drawings, use of real objects from the lab. That was a good example of a *top-down process* solicited by a bottom-up process.

Every example that was briefly described in this paragraph, and the many others for which there is not enough room in this poster-paper, was followed by further occasions of consolidation, as to use concepts in solving problems. Collaborative and individual concept mapping activity, that followed, resulted very

facilitated, especially in the critical revision process, thanks to the previous capillary activities of meaning construction and, in the fifth grade, to the "idearia", that will be shortly described in next paragraph.

3.2 Portfolio as "idearium" vs emerging concept maps

In 2010-11 I attempted to construct class portfolios of emerging knowledge as concept maps. These concept maps collaboratively grown up from "skeleton" or "sprout" cmaps, sometimes picking concepts from parking lots (Novak & Cañas, 2008), and were enriched by images, links and –most important – sticky notes, that we called *ideas*, to distinguish them from concepts. The ideas in the sticky notes demonstrated soon their usefulness as ways to capture propositional argumentations as simple sequences, easily generated, shared and edited in class debates, so in 2011-12 in fifth grade I switched from cmap class-portfolio to "Idearium" or emerging knowledge repository. The ideas that students were attaching as sticky notes to portfolio cmaps, were not part of individuals' true evolving speaking/thinking system after a short time as a single day, whereas the shared list of numbered ideas in the shared Google doc *idearium* were daily negotiated and revised, being readily recognized as a authoritative reference by everyone. Individual insights become collective in the live discussion and negotiation, the strength point of the fifth grade class, whose students were accustomed to critical and constructive debates. Idearia were successfully used to support subsequent highly demanding problem solving activities, and even individual concept mapping resulted often a spontaneous and enriching activity. Individual concept maps based on idearia was made by students and were discussed and refined collectively in the class, displaying an important role in highlighting new concept and in reaching the highest levels of awareness.

4 Conclusions

Action-research reflections before, during and post concept mapping, and other kinds of speech and text transformation activities – included concept mapping - suggest that all these strategies should be considered as concurring approaches to the main and common educational aim of *conceptual thinking*, agreeing with Kandiko & Hay (2010) claim of a "wider range of representational forms… [to learn] from the whole of narrative". It's important to state objectives and reasons of these activities, to avoid feelings of arbitrariness to transform our student-learners in allies too. It's also advisable to highlight and verbally socialize the positive effects, when these effects emerge firstly as a teacher's perception only. Also this pedagogy can profitably become the object of shared awareness.

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