Concept Maps: Making Learning Meaningful
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MONITORING INDIVIDUAL AND COLLABORATIVE KNOWLEDGE STRUCTURE USING COMPUTER BASED CONCEPT MAPPING

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Abstract. Monitoring and assessing conceptual development of students is a highly demanding task. Especially in collaborative learning environments, there is the necessity to record closely and evaluate systematically students' knowledge structures, collaboratively formed, as members of a group and individually formed. It is recognized that achievement tests alone are inadequate and that graphics such as concept maps are more sensitive to subtle changes in student's understanding. In the following paper a case study in which ten years old students participated, using concept mapping software is presented. They constructed and revised concept maps at various phases of a course both individually and collaboratively. The research aims at highlighting concept maps as a more sensitive assessment method of the learning process, comparatively to traditional tests and furthermore at highlighting their effective use as a monitoring and assessment tool in collaborative environments.

1 Introduction

The nature of conceptual maps is dynamic as long as they represent knowledge structure and development. They record knowledge structures of learning and, if taken in regular phases they describe the transition from a stage of knowledge to another. Thus, as learning strategy, concept mapping is more effective when it is carried out with a long-lasting prospect. The study of a conceptual map's sequence which were constructed in various phases of learning process is able to reveal a student's transition from pre-existing knowledge structures to new ones (Carey, 1986; Wallace & Mintzes, 1990; Novak & Musonda, 1991). Under this prism, the conceptual maps may also constitute a student's conceptual development study tool (Pearsal et al., 1997). In other words, in the framework of constructivism, learning process does not necessarily aim at the adoption of a scientific model, but at the construction of new knowledge. For this reason a method of study and evaluation of students' maps does not necessarily include the comparison with the educator's map or an expert's map. Alternatively the comparison of conceptual maps of students in different snapshots of the knowledge construction process may be used. Thus, the researcher investigates equally the learning process as well as the learning results (Novak & Musonda, 1991; Iuli & Helleden, 2004). This process can be simplified with the use of concept mapping software.

2 Theoretical Framework

Concept maps are a cognitive tool variously used in the learning process. They were first presented by Novak and Gowin (Novak, 1977; 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 & Gowin, 1984; McAleese, 1994; Fisher, 1990) and to reveal the representations of the person that takes part in the learning process (Jonassen & Marra, 1994; Fisher, 1990).

In a constructivist framework 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 by using, expanding, revising or erasing the pre - existing representations. Thus, the study of representations is a crucial matter in order to design appropriate educational environments. Therefore, the starting point of learning is what a person knows or ignores before teaching (Novak, 1977). Concept maps are able to record student's knowledge structure before teaching and also in the various phases of a course. They measure aspects of learning which conventional tests do not measure particularly well. For example, concept mapping can provide information about students' misconceptions and incorrect conceptions, which are usually unavailable in conventional tests (Heinze-Fry & Novak 1990; Roth & Bowen, 1993). Furthermore, traditional tests that are taking place after the completion of teaching procedure do not allow a complete view of how students construct knowledge during it and often assume that group members have made equal contributions to the task and give the same grade/reward to each member, which is unfair and

usually insubstantial (Roth & Roychoudhury, 1993). Though learning is a dynamic and progressive process, monitoring it in a collaborative environment means first monitoring both individual and collaborative learning and additionally monitoring them in various phases of the procedure. However, monitoring the learning process is a complicated and demanding activity. It often requires external support to keep track of what has happened and what is going on in the learning process (Wang, 2009). Research reveals that many Information and Communication Technologies (ICT) tools can be used to monitor the learning process. In this paper a computer mapping software is proposed and used.

3 Methodology

3.1 Objectives of the study

The study aims at highlighting concept maps as a more sensitive assessment method of the learning process, compared to traditional tests and at highlighting their effective use as a monitoring and assessment tool in collaborative environments. Thus, the objectives of the study are:

1. To highlight the use of concepts maps as a way to simultaneously monitor individual and collaborative knowledge structure.
2. To highlight the use of concepts maps as a way to monitor learning process as well as the learning results.
3. Thus, to highlight the advantages of the use of concept maps as an assessment tool in comparison to the traditional evaluation tests.
4. To highlight the use of concepts maps as a tool to reveal conceptual representations and finally
5. To highlight the advantages of computer supported concept mapping in real class conditions.

The following sections present the relevant research.

3.2 Research participants, settings and concept mapping software

The research took place in real class conditions. Sixteen, ten years old students participated, forming eight groups, two members each. Groups were formed by evaluating the students' answers to questionnaires about the topic, setting as a criterion their common ideas about the subject of the course, which was: "Energy and environment". Every group constructed and reconstructed individually and collaboratively concept maps before and after various phases of instruction, using concept mapping software. A free concept mapping software was used, named "ModellingSpace", which was developed from University of Patras in collaboration with the Aegean, Angers, Lisbon, Mons-Hainut and SclumbergerSema Universities (www.ecedu.upatras.gr). The research started with the study of conceptual representations as they appeared in concept maps structured by students before teaching, individually and collaboratively. Then, a course was designed, taking into consideration these representations. During the course students individually and collaboratively constructed, revised or reconstructed their maps after various phases of the teaching process. The maps which were collected, after every phase of the instruction, were studied immediately in order the researcher to receive an immediate feedback about the group's function, its members' progress and the instruction's effects and to be able to coordinate the learning environment accordingly. The assessment protocol used was elaborated from the researchers and evaluated the structure, the concepts and the propositions in quantative and qualitative terms. Detailed presentation of the course's content and the assessment protocol extends the scope of this paper but we believe that the proposed methodology of monitoring knowledge structure using sequences of individually and collaboratively structured concepts maps can be applied regardless of them.

4 Results

The research process described above resulted in collecting sequences of individually and collaboratively structured concept maps. Thus, we had the capability to assess individual and collaborative knowledge structures in various phases of the course and through comparative analysis to locate possible interactions between members of the group. We present indicatively the comparative analysis of a number of individually and collaboratively structured concept maps, by the group named "Energy":

The individual concept map, constructed before teaching by the first member of group "Energy" records the existence of conceptual representations about the forms of energy, its sources, and a possible differentiation in types of sources (renewable and not renewable)/ This differentiation is presumed because the concepts "coil" and "oil" are linked to negative environmental consequences (Figure 1). The individual concept map, constructed before teaching by the second member of group "Energy" reveals that his conceptual representations about the concept "energy" are exclusively about energy's usefulness to living organisms through nutrition, but without definite comprehension of this process (Figure 2).

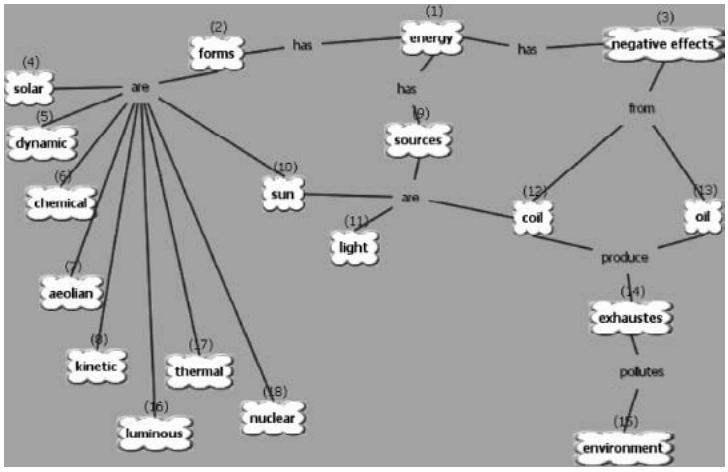

Figure 1. Individual concept map, constructed before teaching by the first member of group "Energy"

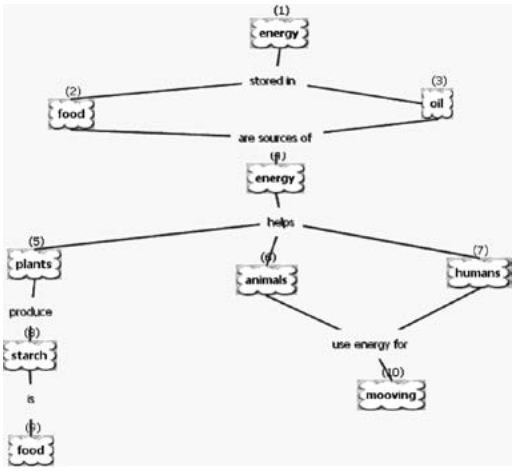

Figure 2. Individual concept map, constructed before teaching by the second member of group "Energy"

The two members of group "Energy" after the individual construction of concept maps before teaching were asked to collaboratively construct a map. The collaborative concept map, which was constructed before teaching by the two members of group "Energy" was a map exclusively affected from the first member of the group (Figure 3). His conceptual representations about the forms of energy, its sources, and its environmental consequences are recorded again. The conceptual representations of the second member of the group about energy and living organisms are absentees. Although the first impression is that the first member structured a concept map without the participation of the second member the collaboratively structured map is of better structure, richer in concepts and propositions than the one structured by the first member individually (Figure 1). Thus, it is possible this is owed to students' interaction. The individual concept map, constructed after the first phase of teaching by the second member of the group "Energy" is a map totally affected from the teaching process, meaning that adopts the concepts which were presented during it (Figure 4). This member's conceptual representations were limited to energy and living organisms. He chooses to exclude them and to follow the sequence of teaching. Although he did not contributed at the construction of the first collaborative map, at least in an obvious way, when he individually constructed his map he adopted concepts emanating from the collaborative map: "coil", "oil", "sun" (Figure 4).

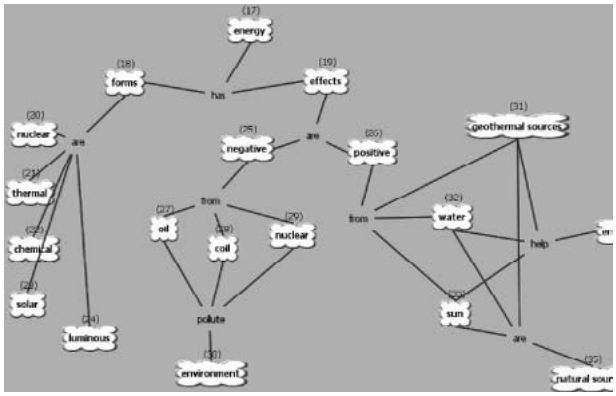

Figure 3. Collaborative concept map, constructed before teaching by the two members of group "Energy"

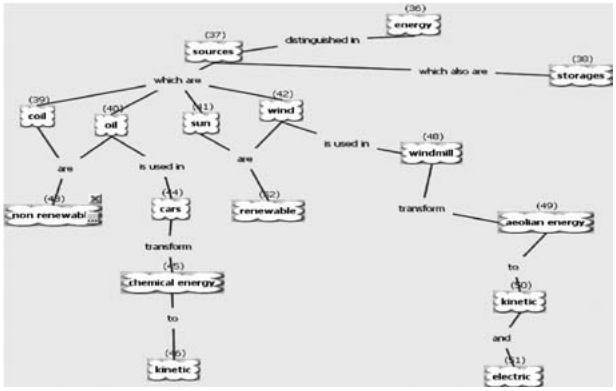

Figure 4. Individual concept map, constructed after the first phase of teaching by the second member of group "Energy"

5 Conclusions - Future perspectives

We believe that the research presented above succeeds in highlighting the use of concept maps as an alternative method to monitor closely and synchronously with the teaching procedure the individual and collaborative learning process. Also its use was proved suitable and effective in revealing conceptual representations. More specifically, the conceptual representations recorded tend to be preserved when they are cohesive. On the contrary students usually abandon them when they are poor. Furthermore when the two students of the group collaborate, the one with the individual map of better structure and content tends to affect more the construction of the collaborative map, which is always better than each individual. Finally, the member of the group which affects less the construction of the collaborative map usually adopts concepts from it when he constructs his new individual map. In addition, the advantage of using concept mapping software, concerning easy construction, revision and storage were also revealed in practice. The whole process raises various issues for discussion and places future research prospects. First of all, the question about how the conceptual maps can be used as an assessment tool with generally accepted reliability, remains open. Our opinion is that an assessment protocol that combines the evaluation of qualitative and quantative elements of a map and which is tested in various topics and by various evaluators, is able to fulfill the need for reliability. Also the process of construction, collection and analysis of conceptual maps even if it becomes easier in a computer based environment, is time-consuming enough. Thus, raises the issue of the wide use of concept mapping in the school routine. Still in the present research the influence of the software in the learning process was not investigated. According to the relevant theory its influence exists and remains to be researched, possibly by the parallel construction of conceptual maps by pen and paper. Finally, the design of a collaborative environment also influences the learning results. In other words the choices made in the present research process concerning groups' synthesis, didactical activities, cognitive tools and learning strategies, influenced the research results. Modifications of this methodology would constitute perspective for a new research.

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