A COMPUTER ASSESSMENT TOOL FOR CONCEPT MAPPING

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ABSTRACT
Current educational theories emphasize assessment as a vital part of teaching-learning process. Alternative assessment techniques aim to expose and promote the process of the learning rather than the final outcome. Concept mapping is a technique for representing conceptual knowledge and relationships between concepts in a graphical form. Requiring to construct concept maps encourages learners to organize concepts and the relationships between them in a hierarchical structure. Although constructing concept maps might be difficult in every domain including mathematics and might require extensive domain knowledge, it is essential to employ concept mapping technique in order to reveal learner's conceptual understanding. Hence, asking learners construct their concept maps or to fill missing parts in a pre-designed concept maps might be used as a part of the assessment process. A prototype computer system, called Concept Map Assessor (CMA), is designed to help learners to construct concept maps and to evaluate their performances in pre-designed concept maps. In this study, the basic features and elements of the CMA will be presented and its possible contributions to mathematics education will be discussed.

INTRODUCTION

Assessment is essential part of teaching-learning process. It gives the picture of what students gained and problems they had. Classical assessment techniques such as multiple choice, true-false type tests, etc. emphasize the product not the process. Alternative assessment techniques have developed to assess the process not the product (Anderson, 1988; Nowak & Gowin, 1984). Concept mapping technique can be viewed as an example of alternative assessment techniques. This paper will explain how to use and assess this technique in mathematics domain, give information about computerized version of concept mapping technique called Computerized Concept Map (CCM) and a few examples with computer screen shots will be provided.

CONCEPT MAPPING IN MATH

The idea of letting students to construct concept maps was developed by Novak and Gowing (1984). This technique was supported on the studies of different mathematics educators (Skemp, 1987; Park & Trave, 1996; Lanier, 1997). The process of making concept maps helps students understand connections between different ideas. Mathematics requires abstractions based on concrete, semi-concrete or abstract experiences of students. Organization of mathematical ideas or relations is vital and most students have problems on developing relational understanding. Engaging in meaningful learning requires relevant prior knowledge, meaningful material and the choice of the learner (Novak, 1998). Concept maps enables students to relate newly learned ideas. It also helps students connect new ones with old ones (Mwakapanda & Adler, 2002, p. 62).

The idea of concept mapping can be rooted back to the studies of Piaget and Ausebel. New piece of information causes the disequilibrium with old ones, then student reach to cognitive equilibrium by assimilation or accommodation. Reaching to cognitive equilibrium means that students formed the new cognitive/conceptual schema (Hamachek, 1986). Concept maps is a mean to force students to organize their conceptual schema and present it in a peculiar way (Roth & Roychoudhury, 1992, p. 357). This representation gives teacher chance to assess their and students' learning. Misconceptions can be revealed by asking students to construct concept map.

Concept maps are dynamic and students add new components based on their experiences. Since mathematics consists of complicated and complex forms of relations, as students gain more insight, they develop complicated and integrated concept maps. Concept maps were constructed mostly at the end of a lesson and/or subject. This way, students reorganize their ideas and make connections between the smaller points within the subject. For example, one could construct concept maps about quadrilaterals. By the help of a concept map, one could visualize the certain relations under a specific condition among different quadrilaterals such as trapezoid, parallelogram, rectangle, rhombus and square (See Figure 1).

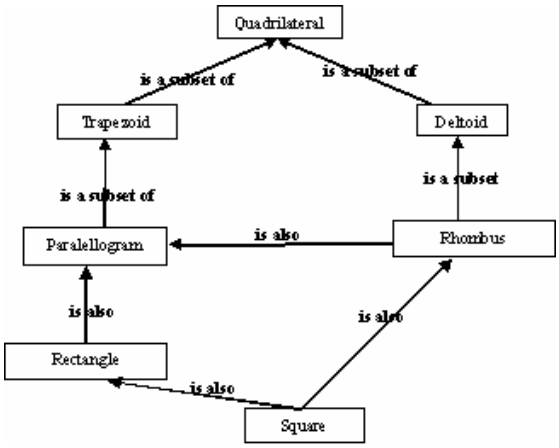

Figure 1. An example of a paper-and-pencil concept map about quadrilaterals.

COMPUTERIZED CONCEPT MAPS

There are many software packages for constructing concept maps such as MindGenius for Education, Mind Mapper, Inspiration, Decision Explorer, Activity Map, Kidspiration, MindGenius, Mind Manager and StarThink (The Concept Mapping Homepage, 2004). Concept maps provide a new method for organizing and browsing through information and may be an effective navigational tool for hypermedia environments (Cañas, Ford and Coffey, 1994; Ford, Cañas and Coffey, 1993). The concept map tools (CmapTools) stretch the usage of concept maps beyond knowledge representation and might serve as the browsing interface to a specified domain (Cmap Tools, 2004).

There are two different approaches for designing concept mapping software: structured and unstructured. Structured approach requires users to construct concept maps in a pre-specified format such as a flow diagram or a cyclical cycle while an unstructured approach gives users freedom to choose their own format. Inspiration, Kidspiration use unstructured approach while MindGenius, Mind Manager and StarThink use a structured approach.

Concept maps might show variances with respect to the individual interpretations in terms of both being general or specific and its coverage. Hence, it is very unlikely that two students produce the identical concept maps for the same task. Since students' concept maps might not include the central ideas of a domain, it is difficult for teachers to grade them in a standard way. While unstructured approach is suitable for designing novel concept maps, structured approach might be more appropriate for assessing students' conceptual structures because of the students' difficulty of constructing concept maps from scratch.

ASSESSMENT WITH CONCEPT MAPS

Assessment is one of the most important parts of educational process that directs teaching, learning as well as curriculum development. Alternative assessment techniques are very important because of their focus on conceptual and meaningful understanding and process of learning not the product. Concept map as an alternative assessment technique might also enable to externalize students' conceptual understanding and possible misconceptions. Concept maps might give the teacher a clear picture of students' understanding by forcing students to connect and relate ideas within the subject at hand. The aim of this approach is not to pick up a certain concept of the students but to reveal their relational understanding.

Utilization of the scoring rubric is useful when evaluating the students' concept maps. Scoring rubrics give an overview as to what the teachers are looking for in the constructed concept maps. It is very important to have clear definitions about what to look for. It is suggested for a concept map to have a range of 3 to 6 sub-ideas from its main idea since it might require the students to clarify their most important main ideas.

It is proposed that, similar to the distinction between structured and unstructured approach, assessment of concept maps might be done in two different ways. In an unstructured concept map assessment, students may construct flexible concept maps by choosing their own concept and connections. There is a proposed grading mechanism for this approach developed by Novak and Gowin (1984) based on the proximity of the sub-ideas to the main idea and the connections within the same level. In a structured concept map assessment, students may only fill the empty places in a pre-designed concept map with the given concept and relations. There is no grading mechanism that could be applied to this approach.

CONCEPT MAP ASSESSOR (CMA)

We have designed a prototype computer system for making structured concept map assessment called Concept Map Assessor (CMA). CMA could enable users to construct unstructured concept maps. One could use different shapes, colors, fonts, backgrounds etc. for each node and connection in the concept map. CMA interface works bilingually both in Turkish and English.

CMA has two different modes of operation for both constructing a concept map and assessing it. One could transfer the paper-and-pencil concept maps, such as the one in Figure 1, to CMA in the construction mode (Figure 2). This mode is mainly used by the evaluators to prepare the unstructured concept maps for testing students.

In the assessment mode, CMA adopt a structured approach in a way that it limits the usage of students' concepts and relations to the available concepts and relations in the pre-designed concept map. CMA puts another panel containing names of the concepts and relations in order for user to be aware of the possible choices (See Figure 3). Evaluators may also put extra alternatives in order not to trivialize the assessment. Students may drag and drop the names to appropriate places. For the simplicity, this version of CMA allows only the concepts to be moved and relations are shown in their proper places.

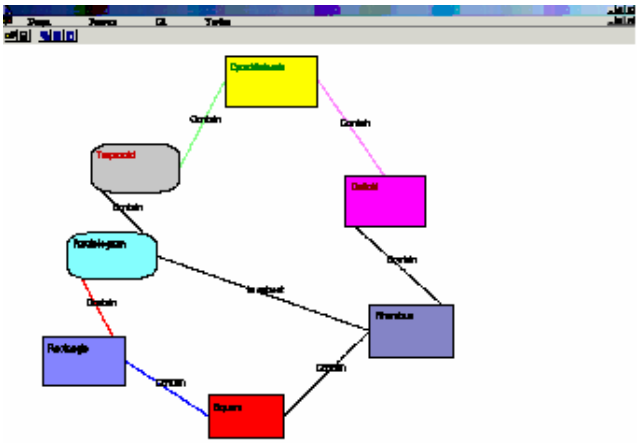

Figure 2. A screenshot from CMA in construction mode.

Scoring of the students' responses in CMA is not integrated to the system yet because of the uncertainty of grading mechanisms of structured concept map assessment on the theoretical grounds. It is proposed that grading mechanisms of unstructured concept map assessment is not directly applicable here. However, the intra-level and extra-level relations of concepts and relations should be taken into the consideration. But, the complexity of the concept map makes the assessment difficult since there might be many main ideas and sub-ideas to be considered. We are still in the process of developing a proper grading mechanism for CMA.

CONCLUSION

There might always be drawbacks in constructing and assessing concept maps since the relations between concepts might be very complex and non-linear. Furthermore, many sub-ideas might also be related to one another aside from their connections to the main idea. Hence, concept maps should be used cautiously in assessment. CMA provides an environment where evaluators may easily construct concept maps of their domain and use them as an alternative assessment tool at least for a diagnosis purpose at this stage. CMA simplifies the usage of concept maps as a part of assessment. It is proposed that CMA has the potential to be used as a part of teaching and learning process provided that a proper grading mechanism is developed.

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