Testing Concept Maps Electronically

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Abstract— Paper deals with using of concept maps in testing knowledge. Concept maps are widely used in education and business because of they aid meaningful learning, help to organize, preserve and summarize knowledge and empower creativity. One can constructe own concept map by many software electronically. But concept maps can serve as qualitative and quantitative means for testing knowledge. Common used methods of testing knowledge are one-dimensional, give relative order in class or percentage rate of accuracy, and cannot give the relations between concepts and hierarchical structure of concepts. Special software was developed and used in testing fuzzy cognitive maps that make possible modelling inner causal relations of concepts in areas or systems changing in time. Results of testing knowledge will be given.

I. INTRODUCTION

Pupils' knowledge and skills are proved by different tests. Common used methods of testing are one dimensional. Results of testing give relative pupil's order in class or percentage rate of accuracy. These results cannot give the relations between pupil's concept and hierarchical sructure of pupil's concepts.

Pupil understands or misunderstands a subject matter. There are many pupils that misunderstand mathematics or science as follows from international testing PISA, TIMMS, etc. Solved problem is searching where is causal this misunderatndig in pupil's thinking. Answer can give the theory concept maps.

II. CONCEPT MAP

A concept map is a diagram showing the relationships among concepts. Concept map is graphical tools for organizing and representing knowledge [1]. Concept maps were developed in 1972 the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science [2]. During the course of this study the researches interviewed many children, and they found it difficult to identify specific changes in the children's understanding of science concepts by examination of inteview transcripts. This program was based on learning psychology od David Ausubel [3], [4]. The fundamental idea in Ausubel's cognitive psychology is that learning takes place by *assimilation* of new concepts and propositions into existing concept and propositional framework held by learner. This knowledge structure as held by a learner is also referred to as the indivudual's *cognitive structure*. Out of the necessity to find a better way to represent children's conceptual undrstanding emerged the idea of representing children's knowledge in the form of a concept map. Thus was born a new tool not only for use in research, but also for many other uses.

The first textbook on this theme "Learning how to learn" [5] was published in 1984 by Joseph D. Novak and D. Bob Gowin. Joseph D. Novak has Slovak origin, grandparents were born near Bratislava.

Concept maps were developed to enhance meaningful learning in sciences. Construction of concept map includes concepts that are usually enclosed in circles or boxes of some type, and relationships between concepts indicated by connecting line linking two concepts. Words on the line, reffered to as as linking words or linking phrases, specify the relationship between these two concepts.

Concept is defined as a *perceived regularity in events or objects, or records of events or objects, designated by a label*. The label for the most concepts is a word, although sometimes we use symbols such as + or %, and sometimes more than one word is used.

Propositions are statements about some object or event in universe, either naturally occuring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement. Sometimes these are called semantic units, or units for meaning. . Figure 1 shows an example a concept map that describes the structures of concept maps an illustrateds the above characteristics.

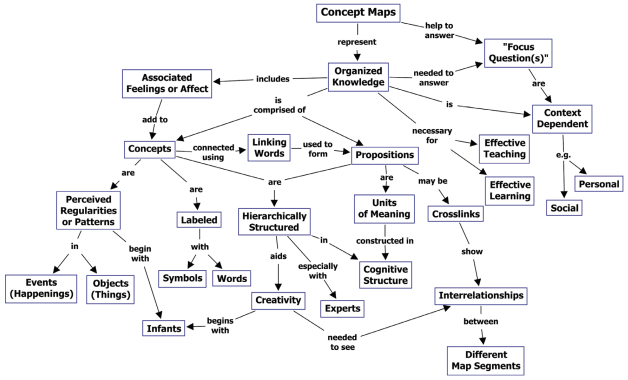

Figure 1 .A concept map showing the features of concept maps (according [1], page 2).

The concept maps are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge depends on the context in which that knowledge is being applied or considered. It is the best to construct concept maps with

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reference to some particular question we seek to answer, which we have called a *focus question*. The concept map may pertain to some situation or event that we are trying to understand through the organization of knowledge in the form of a concept map, thus providing the context for the concept map. Applying a simple graphical convention consisting of hierarchical spatial configuration sets of nodes (concepts) and labelled links between nodes, concept mapping represents the logical structure of a subject matter.

Another characteristic of concept maps is the inclusion of *cross-links* that are relationships or links between concepts in different segments or domains of the concept map. Cross-links help to see how a concept in one domain of knowledge represented on the map is related to a conception another domain shown on the map. Cross-links often represent creative leaps on the part of knowledge producer in the creation of new knowledge. Concept maps can facilitate creative thinking by the hierarchical structure that is represented in a good map and the ability to search for characterize new cross-links.

New knowledge creation is a constructive process involving both our knowledge and our emotions or the drive to create new meanings and new ways to represent these meanings. Learners struggling to create good concept maps are themselves engaged in a creative process, and this can be challenging, especially to learners who have spent more of their life learning by rote.

III. Concept map construction

A person constructing the concept map has to be very *familiar with a domain* of knowledge concept map. A good way to define the context for a concept map is to construct a *focus question*, that is, a question that clearly specifies the problem or issue the concept map should help to resolve. Every concept map responds to a focus question, and a good focus question can lead to a much richer concept map.

The next step is to identify the *key concepts* that apply to this domain. Usually 15 to 25 concepts will sufficent. These concepts could be listed from the most general at the top and to the most specific at the bottom of list. This list of concept is called a *parking lot*, and is only aproximate. Some concepts may remain in the parking lot as the map is completed if the map marker sees no good connection for these with other concepts in the concept map.

The next step is to construct a preliminary concept map. This can be done writing all of the concepts on sheet of paper or elecronically using computer software program such as IHMC CmapTools [6]. Computer software programs are better in that they allow moving of concepts together with linking statemensts and the moving of groups of concepts and links to restructure the map. When CmapTools is used in conjunction with a computer projector or two or more pupils can easily collaborate in building a concept map and see changes as they progress in their work. A concept map is never finished. After preliminary concept map is constructed, it is always necessary to revise this map and the other concepts can be added. Good concept map usually result from theree to many revissions. This is one reason why using computer softwae is helpful.

Students often comment that it is hard to add linking words on the “lines”of their concept map. This is because of they poorly understand the relationship between the concepts, or the meaning of the concepts and it is the linking words that specify this relationship.

Computer-Based Concept Mapping uses software for construction of concept maps. This software is as follows in alphabetical order: Activity Map, Decision Explorer, Diagrammer, Inspiration, Kidspiration, Mind Genius for Education, Mind Manager, Mind Mapper, SemNet, Star Think. There are two conception of software. The first coception has structured approach. User must define format of pripering map beforehand and determine shape of flowchart. No-structured approach gives to user freedom for construction of proper format.

IV. Evaluation and concept maps

New science texbooks include of concept maping as one way to summarize understandings acquired by pupils after they study a unit or chapter. Change in school practices is always slow, but it is likely that the use of concept maps in school instruction will increase substantially in the next decade or two.

When concept maps are used in instruction, they can also be used for evaluation. Now multiple choice tests are used from grade school through university. May be that concept mapping will be used in national examinations as a powerful evaluation tool.

Structure of knowledge is considered as important element of pupil’s understanding. Structure of knowledge successful pupils has elaborate and integral structure bounded concepts that facilitate problem solving and the other cognitive activities of pupils.

Structure of knowledge can be thought to be important but no-measurable component of pupil’s results. Technic of concept maps can represent the structure of pupil’s knowledge and can be means for investigation of concept knowledge structure. Pupil promotes his own private view of concepts and relationships between them on concept map. Thus he vizualizes results of his learning, his preconceptions, conceptions and misconceptions. Misconception is a mistaken thought, idea or notion, false understanding of concept. Misconception is a wrong structure that has to be overcome by pupils with support of teacher.

V. Evaluation of concept maps

Pupil can evaluate his ir her concept map by comparison with concept map in instruction and this way eveluate his or her level of understanding of subject matter.

People who used *unified scoring method* are trained to test every concept map and the pupils’understanding of the conccept that he or she stated in his or her map. According to this evaluation, every map is eveluated with a measurement between 1 and 10 (McClure and Bell, 1990).

The *interrelated scoring system* was adopted from a method which was improved by McClure and Bell (1990). In this method, individual maps composed from independent propositions which were defined in the map, were scored. A proposition is defined as a relationship between concepts, a connection of two concepts

highlighted with connection line. Every proposition was scored between 1 and 3 according to a scoring protocol accepted the proposition as true.

Structural scoring model was adopted from a method which was defined by Novak and Gowin [5]. According to this model, scoring concept maps are made as follows: for each proposition 1 point, for every hierarchical proposition 5 points, for every diagonal connection 10 points, for every example 1 point will be given.

Another model is given as follows: for correct proposition between two concepts 1 point, for every hierarchical proposition 1 point (the last two level arenot take into account), branching – to the first branching 1 point, to the next branching 3 points, correct label between two concepts 1 point.

VI. TESTING CONCEPT MAPS ELECTRONICALLY

Concept maps are valuable diagnostic tool. This tool was used in testing concept maps electronically. Types of test items were as follows: shape of concept map was given, yellow concept was given and the others were given as propositions for pupils, see examples Fig. 2 and Fig. 3.

Goal of test item in Fig. 2 is deper understanding divisibility. Mistakes in solving the concept map give misunderstudings or misconceptions of pupils. These start new way of teaching/learning process.

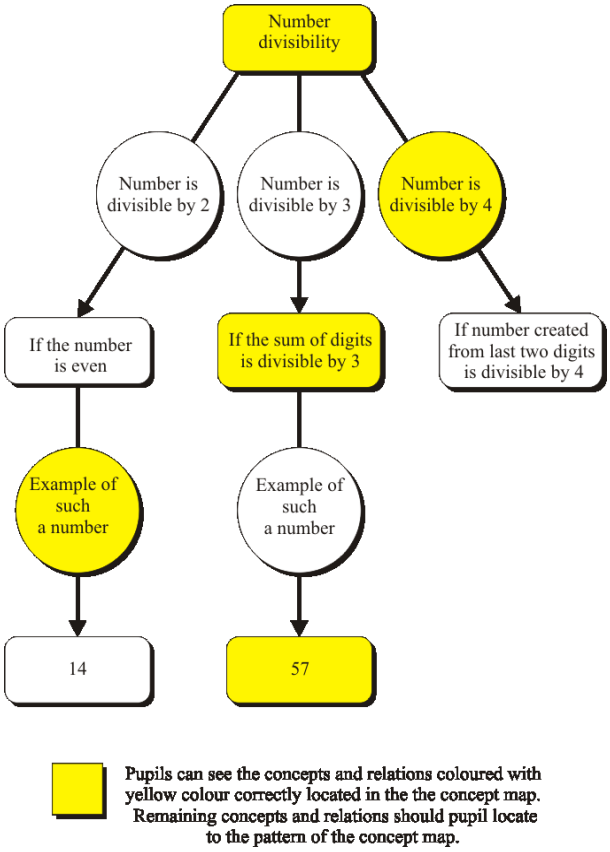

Figure 2. A concept map on divisibility

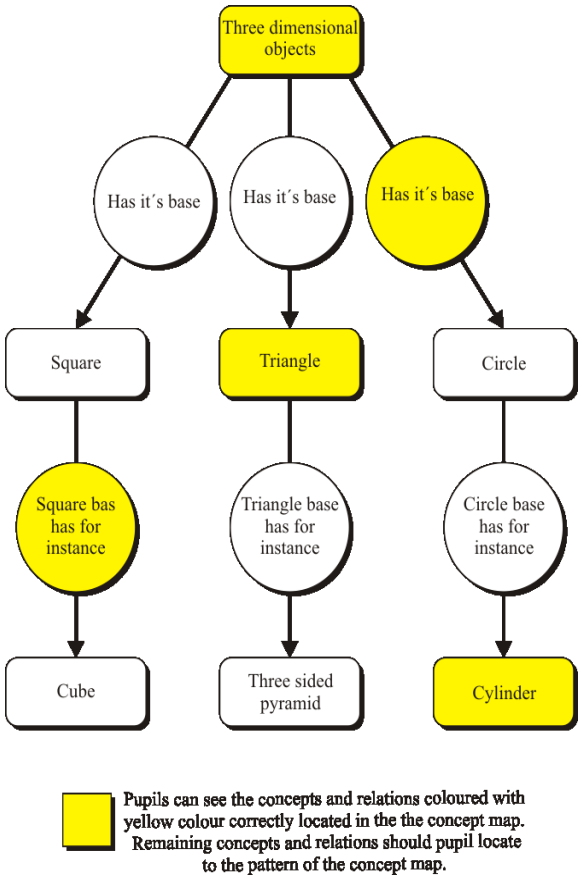

Figure 3. A concept map on three-dimensional objects

Goal of test item in Fig. 3 is deper understanding three-dimensional objects. Pupils have three-dimensional vision very low. Mistakes in solving the concept map give misunderstudings or misconceptions of pupils. These start new way of teaching/learning process with real three-dimensional objects.

Testing was carried out at secondary schools in the Moravian-Silesian Region in September 2011. Total number of pupils was about one hundred. Special programe was developed for this testing and evaluation of testing.

VII. CONCLUSIONS

Concept maps are very useful learning and diagnostic tool as concern understanding of subject matter by pupils and knowing teachers how to facilitate. The construction of concept map penetrates to teaching/learning process in the Czech schools [7].

There is much software on web and some teachers only start using this software. Out of spite this situation, the testing concept maps electronically was carried out and teachers were forced to think about. The data of testing are analyzed for further using in teaching/learning process.

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