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Research Article

Which one works best? --- The effects of varied concept map strategies on solving ill-structured problems

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Abstract: In order to explore which strategy works best to enhance students' ill-structured problem-solving ability, the study utilized concept mapping strategy to evaluate students' performance. 90 undergraduate students, who were registered in the course of Service Marketing, were invited to participate in the study. The preliminary strategy indicated that the students performed differently under various strategies.
Keywords: ill-structured problems, concept map, problem-solving.

INTRODUCTION

Educators are always concerning about how to enhance students' ability on problem-solving. It is the essence of education to help students to adapt the knowledge learned from classroom to the real world. There had been numerous research focused on the topic of problem-solving in the past decades. In the process of problem-solving, the presentation of knowledge structure plays a critical role to effectively enhance the solver's performance [7, 8] as "the essence of knowledge is structure" [1]. Meanwhile, by visualizing the knowledge structure presented by the learner, teachers can easily understand the learners' learning ability and evaluate their performance.

Concept map has been widely used in different classes as a useful pedagogical tool to facilitate students to organize information and implement a higher-level thinking [2]. It is a top-down diagram, starts with a main concept at the top and can be branched out limitless. Composing of concept nodes and connection relation links, concept map is easy to learn and one can visualize the learner's conceptual hierarchy through the map's presentation [5]. It provides a channel to help learners to externalize knowledge and lower their cognitive load effectively in the complex process of learning. On the other hand, teachers or evaluators can easily understand the learners' knowledge structure by observing the presentation of concept map. Prior research [13] reported that during the process of learning, the disclosure of knowledge structure is critical, it shows that how the learner assimilated knowledge. Concept map can clearly present the hierarchy and structure of learner's concept. It makes knowledge become transparent.

Connecting with the real world situation, ill-structured problems are the ones that students have to confront everyday in their future lives. With the characteristics of complex, ill-defined, open ended and authentic, ill-structured problems are quite different from well-structured ones, they are usually unclearly defined and with vague objectives, the related information that required solving the problem is usually insufficient, meanwhile, the solutions of the problems are either multiple or no at all [4]. Apparently, it is much more difficult and complex to solve ill-structured problems than well-structured ones. However, the majority of the research talked about solving well-structured problems, which are usually well-defined, well-circumscribed and have only one best solution, the attention that has been paid on ill-structured problem-solving is sparse.

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In the process of leading students or novices to solve ill-structured problems, it is not enough to merely engage them in the field, instructors need to give them support or use proper scaffolding tools to guide them and achieve the task [20,21] indicated that teaching with guided interaction could be helpful to enhance a higher level of thinking, so it is essential to employ a proper teaching technique to facilitate students to integrate the textbook knowledge and decision ability in the real world. Scaffolding refers to a certain process that enables a novice or a child to solve a problem, implement a task, or achieve a goal which would be slightly beyond his ability [22]. Therefore, we would like to understand if students' ill-structured problem-solving ability can be enhanced by using different pedagogical strategy (concept map), and the objective of the research is to explore if the varied concept map strategy may have different impacts on solving ill-structured problems.

Main Functions of Concept Map

The ease-of-use of concept map has made it a popular pedagogy and easy to be accepted by students in the recent many years. Moreover, it has several important functions which can assist learning [6]:

1. Elaboration function. By linking concept nodes and connection relation links, concept map provides a way for learners to review their concept structure and foster elaboration. During the process of linking different concepts, learners may visualize what concepts are important and how they are interrelated.

2. Reduction function. As concept map is a top-down diagram and starts with a main idea on the peak, it is helpful in recalling the main concept [9], so that learners will be easier to evaluate the importance of the concept and make a decision upon how to link up the different concepts. Meanwhile, the hierarchical structure of concept map enhances on identifying the relevance of concepts.

3. Coherence function. One of the most important advantages of concept map is that it can facilitate the externalization of knowledge and its structure, so the learner's working memory may be reduced and the coherence of concepts can be build up [12]. By viewing the linkage of different nodes and connection relation, instructors or evaluators are easy to judge if the learner's concepts are with coherence. Moreover, during the process of concept mapping, the utilization of similar icons or identical color can also support that the selected concepts possess of specific relation.

4. Metacognitive function. During the process of learning, students usually have difficulties to combine different concepts. Concept map compensates the gap by clearly presenting the knowledge structure of concepts so that it will be easier for students to know well about the whole dimension of knowledge.

METHOD

Participants

90 undergraduate students, who were registered in the course of Service Marketing during a spring semester in 20018 at a university located in the south of Taiwan were invited to participate in the study. They were all new about the pedagogy before. It was anticipated that there were no significant differences among the three groups in either age or gender.

Concept mapping training

Before the experiment started, a designed training was provided for the participants for the implementation of concept mapping. The process lasted for six weeks and each time the training took fifty minutes. First, the students were introduced by the instructor about the function of concept map and interpreted the procedure of constructing a map. Then the students were assigned a problem to practice mapping and were requested to accomplish on the spot. Each time when the students finished mapping, the instructor corrected their works and emphasized the key points of concept map again to strengthen the students' image. The procedures of constructing concept map [14] are presented in Table 2 in detail.

Table 1 Steps of constructing a concept map

➢ Define the problem, in other words, the issue that the map has to resolve.
➢ Differentiating and list the related fifteen to twenty-five key concepts that will be applied to the concept map during the process of problem-solving.
➢ Rank the concepts in the hierarchical form with the most general concept on the top and the most specific one in the lower level.
➢ Start to build up a concept map by taking out the concepts from the list made above and decide where to set them.
➢ Combine two concepts with meaningful words to make them be comprehensive.
➢ After constructing the map, look for cross-links among different concepts and illustrate how the concepts are linked with suitable terms.
➢ Revising the map and realizing that the branches of concept map are limitless and always cannot be ended.

Procedure

First, the students were pre-trained with the new method to solve the problem for six weeks. During the process, students were interpreted by the instructor about the mapping of concept map and the advantages and application of map. Then the students were

randomly assigned to three different groups, and the study depicts three different computer-based concept-mapping versions. Group A is "construct-by-self", group B is "construct-on-scaffold" and group C is "construct-on –expert map".

In group A, students were requested to freely construct a concept map by using the computer-aided drawing software （Inspiration） without scaffolding. Prior research [3] reported that drawing concept map with paper-and- pencil only has the following disadvantages: first, during the concept mapping process, it is inconvenient for an instructor to give suggestions to students whenever necessary; meanwhile, for the process is usually complex for novice students, the "hard to revise" characteristic of paper-and-pencil even enhance the complexity of concept mapping. Moreover, the "paper-and-pencil" method is not regarded as an efficient evaluating tool. Therefore, based on the reasons stated above, we provided computer-aided system to facilitate concept mapping to expel the possible factors that might hinder the smooth of the process.

In group B, students were provided with an uncompleted expert concept map, they need to accomplish the map by filling out the blanks. It was anticipated that it would be helpful to reduce the students' cognitive load and facilitate their ability on solving problems by scaffolding aid.

In group C, students were provided by a completed expert concept map. It was hoped that students would solve the problem more systematically and quickly under the help of expert concept map.

Mapping Software

The participants were equipped with computer mapping software Inspiration 7.6 international version. The software is developed for drawing concept map especially. It provides numerous pictures and figures, which are helpful for constructing concept maps; meanwhile, the easy of use even facilitate learning and instruction. The participants were pre-trained to understand how to operate the software.

MATERIAL

The material of the experiment is an ill-structured problem that related to the field of Service marketing. The participants were requested to solve the problem by using the provided concept mapping software based on their cognitive toward the problem.

Scoring

The scoring method is functioned based on the standard presented by Rafferty and Fleschner [16] by two different evaluators.

RESULTS AND CONCLUSION

After conducting the scoring and interrator reliability analysis, the preliminary results showed that the participants performed variously under different concept mapping strategies. However, the participants of group C outperformed under the assistance of expert concept map. This provided evidences that using scaffolding instrument would be beneficial in enhancing students' ill-structured problem-solving ability. Future researchers could go further to explore how students' problem-solving ability would be improved by utilizing various instruments or skills.

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