Meta-Cognitive Tool Development to Improve e-Learning Environment

Dilek Karahoca, Adem Karahoca, Ilker Yengin, Huseyin Uzunboylu, Ali Güngör

Abstract: *In this study, the meta-cognitive tool development activities are highlighted to improve the e-learning platform. The spiral software development life cycle was taken into account and the learners' learning styles was evaluated as user requirements. After the development phase, the meta-cognitive tool integrated into the course management system of the history of civilization course at the Bahcesehir University. Then the students' achievements benchmarked with the classical power point based lessons with meta-cognitive based tool. Results show that students which are above average might benefit the tool most.*

Key words: *Meta-cognitive tool, concept maps, learning tool development, learning styles model.*

INTRODUCTION

Concept maps could be good tool to view the content and specify the requirements of the knowledge flow in the learning applications. Also the concepts and the relations can be seen at first glance. These benefits of the concept maps show that make the system view more apparent for learners. The concept map approach is categorizing knowledge in the information hierarchy. Learners may understand the knowledge domain which represented in a way that resamples the thinking of the subject matter experts (SMEs). This suggests that when developing an e-learning application, a pre–designed concept maps can be useful. Coffey, describes the usage of concept maps to create a course description based on the idea of an advance organizer. This method is different then linear sequences of topics which typically found in traditional ways [1]. Novak and Iuli claims that use of concept maps as meta-cognitive tools help to think easily [2].

In the higher education, engineering students have some difficulties when they have need structuring their thoughts in a knowledge domain that they are not used. They also often demanded to use their learning skills to create thinking processes and communicate the ideas using learning media that are not appropriate for all learners. When eliciting requirements of individuals in a learning environment and structuring knowledge representations in a well defined manner, concept maps serve a good tool to view the advance organization of the learning contents flow in the applications.

A well designed concept map can be very helpful to improve and systemize the learning processes of these learners and support their learning in unaccustomed knowledge domains. But sometimes the concept maps can be too complex to understand. Thus students fail to follow all the relations on the nodes of the maps. So when taking the different learner requirements into account to provide the whole concepts at once cannot be a solution all the time. The usage of concept maps that serve learning styles is important to cover all the user requirements. Because, different learners have different learning preferences when study in these concepts. According to their learning styles some of them may prefer to see and learn the whole concepts at once but others may prefer to see and learn the concepts within steps. Another consideration point is that some of the learners needs the visual aids to learn the concepts but others not.

In this study, meta-cognitive tool development stages are detailed to share some experiences.

BACKGROUND

University students have some difficulties when creating relations between ideas, knowledge and integrating the information with their prior knowledge [3]. A well designed concept map can be helpful to see the structure of the content at a glance with a visual presentation that fosters learning of complex information more quickly rather than complex and heavy information loaded presentation of words and verbal contexts.

Because of the ease in receiving information for later retrieval, the concept maps are very useful for educational purposes. Another reason that concept mapping is beneficial for the learning is that it serves as a kind of template to organize knowledge and to structure it [4]. Plotnick suggested that some other usages of the concept maps usage helpful in areas such as creativity, complex structure design, learning assessment, brainstorming, and communication of complex ideas [5]. Also there is a possibility of employing the concept map as an advance organizer [3]. An advance organizer is a global overview of the material that is to be learned [6, 7]. The concept map tools can be also in a computerized form to foster students learning. A learning style is the method that allowing individuals to learn more comfortable. Although there is no perfect theory accepted by researchers for the learning styles [8]; implementing a learning style model can be useful in teaching/learning if it matches the learning modes of the students. Felder explains that there are non-matching learning styles of engineering students and traditional teaching styles of engineering professors [9]. In this situation, students get bored and they become inattentive in class. Also they achieve lower scores on tests, and get discouraged about the courses, the curriculum or themselves. In the beginning, they discussed the aspects and dimensions of learning style significance in engineering education. They were saying that there are learners as Sensing and Intuitive Learners; Visual and Auditory Learners; Inductive and Deductive Learners; Active and Reflective Learners and Sequential and Global Learners. Recently they dropped the/deductive dimension, and changing the visual/auditory category to visual/verbal. Felder describes active learners shortly as to retain and understand information best by doing something active with it— discussing or applying it or explaining it to others. Reflective learners prefer to think about it quietly first [10]; sensing learners tend to like learning facts, intuitive learners often prefer discovering possibilities and relationships [11]; visual learners remember best what they see— pictures, diagrams, flow charts, time lines, films, and demonstrations [11] and sequential learners tend to gain understanding in linear steps, with each step following logically from the previous one. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it" [9]. Within the usage of software applications and answering learning styles, the concept maps can be an important tool to get the meaningful learning for the students learning. In the development of such software, students also get control of their learning process by getting the advantage of learning opportunities which technology offers within the instruction [13].

COURSE DESIGN

The instructional designer should consider the arrangements of course content and materials in a well structured manner to create useful course material. Designing of concept maps could help both the instructor and the instructional designer to see the entire course in a big and detailed view. This system view helps them to represent the relations between contents and information. Also the concept maps can be useful for tracking the content of the course. The map should be designed by a person who has strong knowledge about a given topic in a specific context. There are no correct concept map on a specific content, as there can be many different representations of the topic that are correct. To create such strong concept maps; an instructor or an instructional designer should use a software tool to make the process much quicker and useful. There are some commercial tools are available at the market [13].

In this study, F/OSS FreeMind (http://freemind.sourceforge.net/) was used to create the visual presentation of the concept maps. We selected this software because it is user-friendly especially for the instructors. By the instructional designer and developer side, the ability of exporting the data of the visual representation of the concept maps outside of the program in the XML format is crucial. The concept maps

basically can be created to prepare knowledge representation in a form of a graph which is shaped within boxes consists of knowledge texts that have connections by labeled arrows [14].

The concept maps had been created by the two subject matter experts in the learning domain. First SME is the instructor of the "History of Civilization" course and the other is an expert at the history and art. They linked and create the relations for each node for the visual materials and additional course materials that are selected from the visual galleries related to the course. Concept maps were limited with three levels because information must be learned at working memory and it has a capacity of about four chunks in young adults [15]. SMEs completed the concept maps and then they reviewed the maps and discussed the any missing parts such as lack of information. Finally an instructional designer reviewed the concept maps and linked materials for their inner structure of accuracy according to the relatedness of the course objectives. Concept maps provide an initial conceptual frame for learning and this allows the usage of concept maps as a schema for the structured course. In our study, the presentations were constructed according to these schemas. To link visual materials such as historical maps, illustrations and pictures for each concept also should be included into presentations. All the participant students of the course have studied the presentations in their class hours. Presentations were designed in a linear way; so all the contents were presented sequentially. All the learners learn through the presentations and examples in this order and the order was not changed. This kind of the structure does not adapt to individual learners and cannot support different learning styles.

THE SPECIFICATIONS OF META-COGNITIVE TOOL

A learning tool has been developed to get the contents to fit exactly within concept maps so the learners can have a chance to examine the lessons of the course in an organized way that was indicated also in concept maps. When developing such a tool, there are some encountered constraints. Such as,

1. The tool should provide lessons and related materials in a way that matches within concept maps
2. The tool should give the presentations of the contents both in sequential and global layouts
3. The tool should give the presentations of the contents both in verbal and visual.
4. The tool should provide a navigation that is easy to learn and use.

The learning tool designed to cover the requirements stated above. When developing this kind of learning tool it was essential to access both in class during the lecture hours and online for the future usage as an e-learning tool. Also the portability of the learning tool was an important issue. For this reason, the Adobe Flash framework was used. Both PCs and Macintosh based systems can easily connect to application without need of having to connect to Internet. Another reason of selecting Flash was to have a capability compatibility of XML. While developing the learning tool there was a crucial requirement to provide lessons and related materials in a way that matches within concept maps. To handle these requirements the presentation contents was used matching exactly same of the concept maps by using the XML which included the data of the visual representation of the concept maps that were exported outside of the program. The learning tool just loads XML automatically and programmed to analyze loaded data to present related materials in visual and verbal forms that were indicated by the SMEs within concept maps. The figure 1 demonstrates the essential screens of meta cognitive learning tool. At the top of the screen, there is a toolbar which has three combo box menus to access the visual concept maps that are interpreted from the concept map data. The label 1 indicates the menu of pictures. The tool bar below is for

navigations. At the bottom of the screen, there is an information collection purpose button which may be used for accessing helps and documentation of the learning tool and its usage info. The button next to it is for accessing other chapters list via a pop–up screen. When user jumps to other chapters of the learning tool, it loads the related data of the concept maps by using XML format. The buttons labeled with arrows and may be used to move forward and backward in the program. The learners can navigate in the application by two different ways one is sequential and other branched web. If a user learn in a sequential steps it has chance to use linear model, if conforms in global they can switch to branched web. To access the branched web navigation the user should go to content map form upper menu and move in the concept maps. When user switches concept maps to navigation, the main screen and navigation buttons also changes as the prev./next buttons replaces within a -/+ button set for zooming control of the maps. Also vertical and horizontal scrollbars are included to move in this concept maps. When in sequential mode has been selected the overall relations of the concepts at nodes has been deleted to ensure the sequential learner have easy with following the concepts.

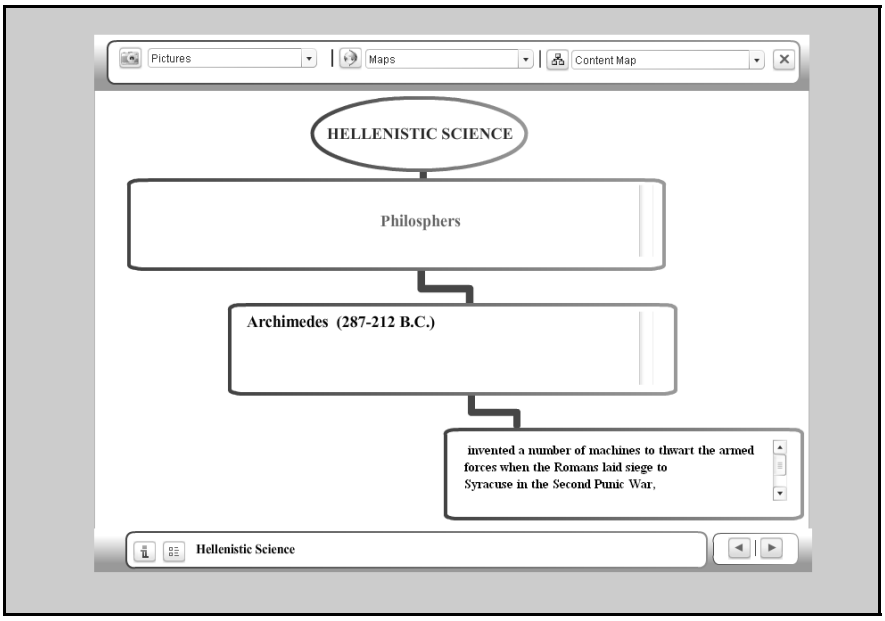

Fig. 1. Meta-cognitive tool loads content by XML

METHODOLOGY AND PROCEDURES

Participants

The study applied in "History of Civilizations" courses with students (n=167) of Faculty of Engineering at the Bahcesehir University. The participants were 167 undergraduates who attended all the lessons with power point presentations, with age (M=19, std.dev.=0.95).

Index of Learning Styles

Index of Learning Styles (ILS) instrument has 44 items. ILS instrument applied to the engineering students (n=167). The ILS results could give an indication of individuals' learning preferences and profile. The Index of Learning Styles is an on-line instrument to assess preferences of students on four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global) of a learning style model formulated by Richard M. Felder and Linda K. Silverman. The instrument was developed by Richard M. Felder and Barbara A. Soloman of North Carolina State University [16]. The reliability and validity of the Index of Learning Styles has been tested in several studies and significantly found that is a suitable psychometric tool [17-

18]. In this study, only the visual/verbal and sequential/global dimensions were analyzed because of the learning tool is designed to cover these dimensions only.

Phase 1: The Classical Power Point Presentations

In the first phase, three chapters of History of Civilization course has been prepared by sticking to concept maps in the power points slides which designed by the SMEs. Each chapter takes six class hours and it has been given by the lecturer by regarding the contents of concept maps. After completing the classical lessons with presentations that based on concept maps, an online assessment with 45 items employed to students whose were attending all the lessons with power point presentations within 60 minutes time limit. The questions also were prepared by the SMEs according to the concept maps and power point presentations. After phase 1, students were offered to use the concept map tool in all lessons and ordered to complete the LIS inventory when attending to History of Civilization online course portal. These students were administrated the 44 itemed ILS instrument. Even though there was no time limit for completion, all the students finished it within average 60 minutes.

Phase 2: Meta-Cognitive Tool

In the second phase, the other three chapters of History of Civilization lessons have been prepared also sticking the concept maps. Then all the chapters are administrated by using the new developed module of online course management tool and the concept map based learning tool implemented both for the online and in class usage. After then, students were introduced the usage of the learning tool and they explored the tool freely in class for 10 minutes. They also recommended for trying the tool within online system. After a week later, the students get accounted to the tool, the lectures takes six class hours for each given with using concept based tutorial tool. After completing lessons with using the concept map based tool, another online assessment with 45 items employed to the students who was attending all the lessons with concept map based tutorial tool presentations in class or online within 60 minutes time limit. The questions also were prepared by the SMEs according to concept maps information. To ensure to have the same difficulty for the course content and the online assessment questions, the SMEs whitened in a dependent rating score.

CONCLUSIONS

As seen in figure 2, the students who get scores above the average of 55 points (std.dev.=18) of 100 points grades also achieve well and can get scores above the average of 60 (std.dev.=15) points out of 100 points. Difficulty of items has been balanced with the assignments of the both studies by the SMEs. We can suggest that students who are above average, they can benefit from the meta-cognitive tool. The students who are at average level at both studies are getting different scores that are unbalanced and unstable. Some of the students obtaining improvements but others show fails. On the other hand, students that far below the average are gets significant fall. The results shows that when developing a concept based learning tool, the students that can manage their learning by themselves and get higher scores in the classical power point based learning also gets higher scores and the usage of tool improves their performances and achievements. But the students who get average scores shows non-stable and significant improvements using the Meta

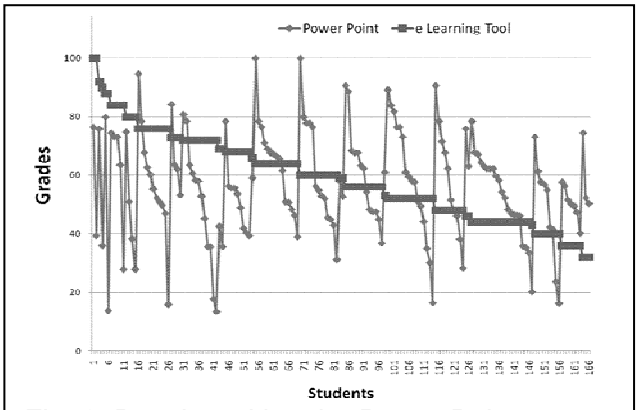

Fig. 2. Benchmarking the Power Point Lectures versus Meta-Cognitive Tool

cognitive tool. Students who are low achievers and far below the average of the first study cannot benefit the tool and their usage of the tool decreases their performance. The usage of such tool instead of classical PPTs within the control of the lecturer at the first hand cannot be suitable for low achievers. The results show that meta-cognitive tool that based on a concept map methodology is very useful and the addressing learners needs of achiever students above the average.

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ABOUT THE AUTHORS

Dr. Dilek Karahoca, Department of Software Engineering, University of Bahcesehir, Phone: +90212 381 0587, E-mail: dilek.karahoca@bahcesehir.edu.tr.

Assoc.Prof. Adem Karahoca, PhD, Department of Computer Engineering, University of Bahcesehir, Phone: +90212 381 0560, E-mail: akarahoca@bahcesehir.edu.tr.

İlker Yengin, College of Education and Human Sciences, University of Nebraska, USA.

Assoc.Prof.Dr. Hüseyin Uzunboylu, Department of Computer Education and Instructional Technologies, Near East University, Lefkosa, Northern Cyprus.

Prof. Ali Güngör, PhD, Department of Computer Engineering, University of Bahcesehir, Phone: +90212 381 0555, E-mail: aligun@bahcesehir.edu.tr.