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Effects of Using The Computer Based Concept Maps in The Web Based Dıstance Educatıon for Processors Courser

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Abstract

In this study, students' views on the teaching of microprocessors through Web Based Distance Education (WBDE) using Computer Based Concept Maps (CBCM) were surveyed. Teaching materials were designed in the scope of the study to teach microprocessors to the students. Two questionnaires were administered at the end of the study to survey the students' views, one consisting of 9 questions concerning features of the CBCM and the other consisting of 11 questions concerning the teaching of CBCM through WBDE. Impacts of the demographic profile (personality characteristics) of the students who took part in the questionnaire were also reviewed. With regards to the features of the CBCM questionnaire, 77% of students replied "Completely agree" and 23% responded "Agree." As for the CBCM through WDBE questionnaire, 72% of the students replied "Completely agree" and 28% responded "Agree". ANOVA and t-tests indicated that the demographic variables of the students did not add a significant difference to these results.

Introduction

Adolescence is a critical period during which effective beliefs in developing one's character are established. One of the skills in dealing with problems during adolescence is perceived social self-efficacy. According to Caprara, Steca, Cervone, and Artistico (2003) those with high self-efficacy experience less tension during adolescence. A great variety of written, oral, visual, experimental and pedagogical educational materials and methods have been developed in the past and present in order to correctly (without misconception) teach concepts to students. Concept mapping is a technique that visually indicates relations between concepts in the form of shapes (McGowen & Tall, 1999). Concept maps relate concepts to the knowledge we possess and uncover relations that we failed to notice before. In this respect, concept mapping is a creative activity (Novak, 1998). Moreover, concept mapping is a strategy that encourages students to organize their knowledge, discuss the significance of the concepts, eliminate misconceptions and gain well-developed learning skills (Novak & Gowin, 1984). Use of concept mapping gives students more confidence in their comprehension ability (Liu, Chen, & Chang, 2010).

A large number of conventional educational materials and methods have been integrated with information technologies thus transforming them into e-education materials. Research results showed that different web-based concept learning curriculum components such as science pictures, flash (animations), video, online notebook, interactive activities, computer usage and online test induced a relatively high cognitive load, and that a lower cognitive load resulted in better concept achievement (Chang & Yang, 2010). Due to advantages such as the ease and speed of transportation, access and use, e-education materials become increasingly popular and gain importance. McGowen and Tall (1999) have claimed that computer technologies facilitate formal as well as symbolic storage of knowledge by

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an individual. In this respect, Computer-Based Concept Maps (CBCMs) prepared on a computer and presented to the students may ensure that concepts are learned in a more intelligible and permanent manner. CBCMs offer benefits in that they can be saved, printed, edited, merged, easily focused on, larger maps can be created and they encourage further research. All these features make CBCM an e-education material with rising popularity.

Distant e-learning models can be built on virtual platforms such as e-mail, communication groups and forums using Communication and Information Technology (IT) in order to provide e-education materials. Web-Based Distance Education (WBDE) is currently the most popular and effective model of distant learning. In WBDE, individuals can be educated without dependency on school and independent of the place and time. A number of conventional tools such as a building, class, desk and board required in the traditional education system are not required here. A lesson simply requires that students connect to the web site of the course/class using computers at their own homes. Moreover, lessons in WBDE cost 40%-60% less than they do in traditional education (Horton, 2000).

Technical and Vocational Education (TVE) is an important subject with a continually expanding scope and therefore frequently renewing definition. The definition of TVE has been revised as “a comprehensive term referring to those aspects of the educational process involving, in addition to general education, the study of technologies and related sciences, and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of economic and social life”. Studies that have been conducted on the matter conclude that the importance of TVE in all fields will further increase in the future. Employment in the field of Computer Science (CS) in the timeframe from 2008 to 2018 is expected to rise by 24%, beating average increases in all fields (U.S. Dept. of Labor., 2010). These expectations of rapid development and remarkable advance allow us to predict that more importance will be attached to TVE in the CS field. This situation will trigger a revision on the academic curriculum in the CS field in terms of hardware, software and all sub-fields on introductory, intermediate and advanced levels that will concern the content and pedagogic aspects (IEEE CS & ACM., 2001).

Topics in CS education should be taught following a curriculum first conceptually and then addressing the hardware and code matters. CS concepts can be generalized as a) algorithmic thinking concepts (algorithmic computation, algorithmic efficiency and resource usage) b) programming fundamentals concepts (data models, control structures, order of execution, encapsulation, relationships among encapsulated components, testing and debugging) and c) computing environments concepts (layers of abstraction, programming languages and paradigms, basic hardware and data representation, tools, applications) (IEEE CS & ACM., 2001).

One of the main subjects of CS is Computer Organization and Architecture (COA). Understanding COA requires the knowledge of the functions of a computer and its structure. The four basic functions of a computer are Processing, Storage, Movement and Control. Generally, the structure of a computer consists of a Central Processing Unit (CPU or Microprocessor), Main Memory, Input Output and Systems Interconnection. A microprocessor has a complex hierarchical structure that performs a number of the computer’s functions. A microprocessor’s structure is comprised by Registers, Arithmetic and Logic Unit (ALU), Control Unit (CU) and Internal CPU Interconnection infrastructures. CU consists of Sequencing Logic, Control Memory and Control Unit Registers and Decoders infrastructures. These structures involve a number of concepts (Stallings, 2006), correct learning of which is important for the correct learning of COA and CS.

In this study, a survey was conducted aimed at teaching microprocessors, one of the basic TVE subjects in the CS field, through WBDE using the CBCM technique. Several studies can be found in the literature addressing the use of concept map-based teaching in the CS field. Yang and Liu studied the use of concept maps in teaching software engineering. In their study, concept maps were used for teaching design, learning, teaching evaluation and group learning in the software engineering field. The authors have claimed that concept maps are an effective tool in software engineering for learning, teaching and evaluation (Yang & Liu, 2009).

In another study, Keppens and Hay investigated the validity, reliability and efficiency of evaluation methods using concept maps in computer programming education. Seven types of methods have been reviewed in that study and differences that separate them have been determined (Keppens & Hay, 2008). Gupta et al created concept modules and concept maps of the modules for teaching of S-parameters, an important subject of RF and Microwave Engineering. They studied the effects of such concept maps on the web-based and CD-based education and determined their advantages (Gupta, Ramadoss, & Zhang, 2003). Another study addressed the teaching of DSP through concept maps (Martínez-Torres, García, Marín, & Vázquez, 2005).

Another study is the use of concept maps as an assessment tool. There are two different approaches in assessment using concept maps: structured and unstructured. In the unstructured concept map assessment, students choose their own concepts and relations, flexibly constructing their own concept maps. In the structured concept map assessment, students fill in the gaps on previously designed concept maps using concepts and relations provided to them (Akkaya, Karakırık, & Durmuş, 2005). McClure et al investigated the reliability, validity and logical practicality aspects of assessments conducted using concept maps. The publication also contains a detailed literature evaluation on the subject. The study concludes that concept maps can be a valuable source of information on the students' knowledge and content (McClure, Sonak, & Suen, 1999). Ruiz-Primo attempted to come up with a response to the question "What have we learned so far?" by offering an assessment system using concept maps. The study addressed the forms of use of concept maps in structural and scoring aspects (Ruiz-Primo, 2000).

The interface design of another tool software application named TPL-KATS and developed by Hoeft et al allows the user to automatically create and score concept maps using commands (Hoeft, Jentsch, Harper, Evans III, Bowers, & Salas, 2003). In the scope of another software project named Concept Map Assessor (CMA), a software application has been designed that assists users in creating concept maps that cover some concepts in mathematics and relations among them and offers the users an opportunity to evaluate themselves using previously designed concept maps (Akkaya, Karakırık, & Durmuş, 2005). Chang et al have suggested a new assessment named "the weighted concept map" for CBCM. The idea first involves assignment of weights from 0 to 1 to concepts on a concept map drawn by an expert to relations among such concepts. This is followed by the determination of weight values of the concept map drawn by the student through comparison with the expert's map. Finally, an assessment is conducted by calculating closeness and similarity indexes (Chang, Sung, Chang, & Lin, 2005). A web-based concept map testing system has been created in an online software application named WCOMT designed by Tsai et al and its results have been disclosed. The student views about the use of the system, in general, were positive (Tsai, Lin, & Yuan, 2001). Majid et al conducted a study to determine the effectiveness of web-based concept maps for online courses. The results of the study showed that concept maps have advantages as a learning strategy and contribute to the students' understanding of concepts (Majid, Panot, Luan, Leong, & Atan 2006). Novak has emphasized that concept maps can contribute to education in four categories: (a) as a learning strategy, (b) as an instructional strategy, (c) as a means of assessing students' understanding of science concepts, and (d) as a strategy for planning curriculum (Novak, 1990). This study addresses the first three categories.

Method

Integration of the Processor CBCMS to the WBDE

In Strengthening Vocational Education and Training Project (SVET, 2002-2007), a joint project of Ministry of National Education of the Republic of Turkey and the European Union, lesson plans and curricula of TVE fields have been restructured in accordance with the modular system. Modular teaching is an approach that focuses on student-centered and individualized learning and teaching. An education curriculum consists of modules. Parts of modules follow a planned sequence. Each module gives knowledge and skills addressing a certain competency. The microprocessors module has been prepared for the Fundamentals of Information Technology (FIT) course of the IT field in the scope of the project, which involves preparation of over 5000 modules (European Commission, 2007).

Teaching material has been prepared in this study aimed at teaching the microprocessors module through WBDE using the CBCM technique. Students' views have been obtained and impacts of the material on the students have been determined. Conduction of the study has been structured in the following phases:

1) Preparation of the teaching material;

a. Preparation of CBCM to present the microprocessors module to the students,

b. Preparation of the textual and graphical delivery of the microprocessors module,

c. Preparation of the animation-supported presentation of the microprocessors module,

d. Preparation of exams to assess and evaluate the students' level of knowledge at the end of the study. Two types of exam prepared: a multiple-choice test and fill in the gaps by drag-and-drop in the CBCM form,

e. Preparation of a WBDE platform to teach the students about CBCM.

2) Implementation of the teaching material;

a. Teaching the students about the use of concept maps,

b. Teaching different subjects of the microprocessors module to the students throughout 8 weeks using CBCM,

3) Assessment and evaluation;

a. Assessment and evaluation of the students' level of knowledge in the subjects of the microprocessors module using the previously prepared CBCM at the end of the training, obtainment and evaluation of the students' views on the teaching material.

Preparation of the Teaching Material

Content of the teaching material consists of the microprocessors module (SVET Project., 2007). The module consists of 8 chapters covering the following subjects: "definition and functions of a microprocessor and locations where programs are stored", "microprocessor structure and cache memory", "speed of microprocessors", "microprocessor communication buses", "microprocessor manufacturers", "microprocessor technologies", "accessing microprocessor features" and "microprocessor cooling". Each chapter was taught as a one-week course. Each lesson was prepared as 4 separate pages as follows: concept map, textual and graphical presentation, animation-supported presentation and exam. The pages were designed using Adobe Fireworks CS3, Adobe Photoshop CS3, Adobe Flash CS3 and Dreamveawer 8. The students could switch to any of the pages using the buttons on the interface of the lesson homepage.

Fig. 1 presents pages that comprised the content of Lesson 1. The concept map on Fig. 1(a) presents the concepts that introduce and define the functions of a microprocessor and depicts the relations among such functions. The concept map presents all the concepts of the subject that were planned to be taught and relations among such concepts. The student is supposed to study the subject by examining the concept map and reading the relations on the concept expressing them in one sentence per relation. Each time the studying process is repeated, the learned knowledge will become more permanent. By studying the textual and graphical presentation of the subject on Fig. 1(b), the student is supposed to repeat the subject in a traditional way. This will help the student understand the structure of the concept map. The student is then supposed to select the page on Fig. 1(c) to watch the summary of the subject prepared as an animation. Fig. 1(d) depicts the exam of Lesson 1. Exams of Lesson 1 and Lesson 4 are in the form of multiple-choice tests. At the end of the exam, the student has an opportunity to review his or her correct and incorrect answers on the test.

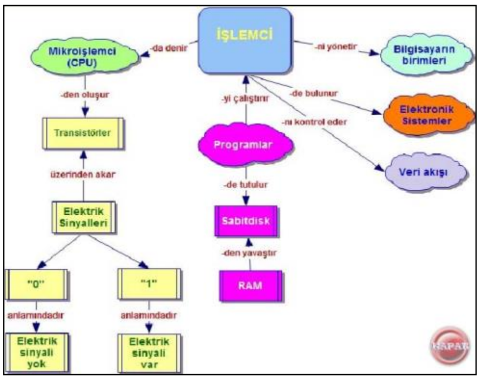


Figure 1(a). *Concept map of the chapter*

Figure 1(b). *Textual and graphical presentation of the chapter*

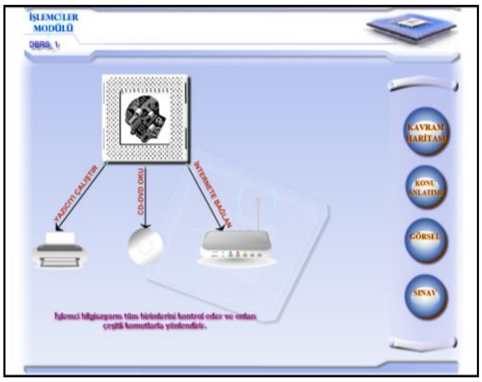
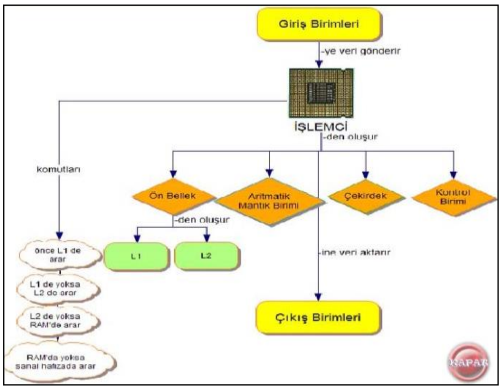


Figure 1(c).*Animation-supported presentation of the chapter*

Figure 1(c).*A multiple-choice test exam*

Figure 1. *Pages comprising the content of Lesson 1: (a) Concept map of the chapter, (b) Textual and graphical presentation of the chapter, (c) Animation-supported presentation of the chapter, (d) A multiple-choice test exam of the chapter.*

Exams of other lessons have been prepared in the form of concept maps. As seen from Fig. 2(b) and Fig. 2(b), in concept map exams, the student was asked to place concepts in the correct location on the map by drag-and-drop the map elements. The exam continues until the student manages to create the correct concept map.Fig. 2(a) depicts the concept map of Lesson 2 and Fig. 2(b) shows the concept map exam. The purpose of the lesson is to teach about the structure of a microprocessor and cache memory concepts.



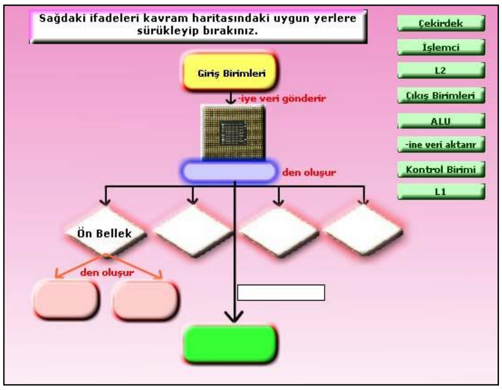
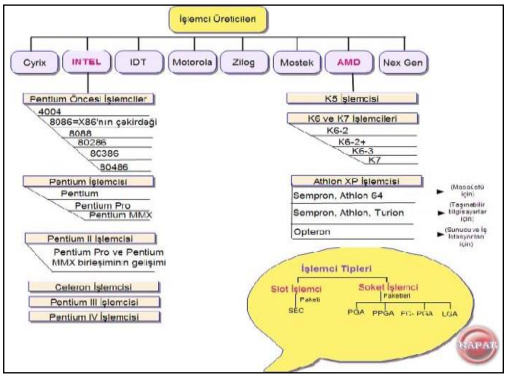


Figure 2(a). *Concept map of the chapter* **Figure 2(b).** *Concept map exam of the chapter*

Figure 2. *Pages with concept maps comprising the content of Lesson 2.*

Fig. 3a depicts the concept map of Lesson 5 and Fig. 3b shows the concept map exam. The purpose of the lesson is to teach the concepts relating to microprocessor manufacturers and microprocessor types.



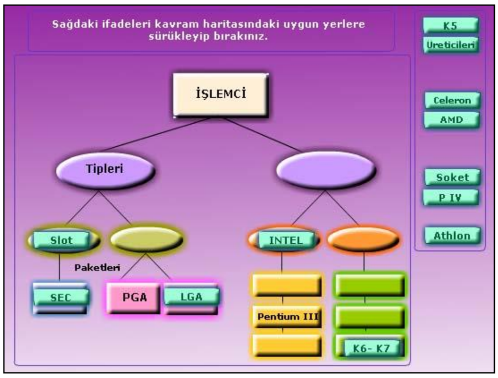


Figure 3(a). *Concept map of the chapter* **Figure 3(b).** *Concept map exam of the chapter*

Figure 3. *Pages with concept maps comprising the content of Lesson 5.*

Preparation of the Teaching Material

During the first lesson, the students were informed about concept maps and how the microprocessors module would be taught throughout the 8 weeks. The students were able to access and review the topics titled “What is a concept map?”, “How to read concept maps?” and “How to prepare concept maps?” at any time before starting a lesson thus refreshing their knowledge about concept maps.

Limitations of the study;

- The sample of the study consisted of 33 10th-grade students enrolled in the IT program of Aksu Multi-Program High School in Isparta.
- The study covers the academic year 2011-2012.
- The study is restricted to the microprocessors module of the FIT course.

Assumptions made for the purpose of the study;

- The students are assumed to have completed all lessons within the teaching material in the internet environment.
- The students are assumed to have gained a sufficient level of knowledge on the use of the concept map technique before the start of the implementation of the teaching material.
- All students participating in the study are assumed to have perceived the questions in the questionnaire in a uniform manner.
- The students are assumed to have answered the questions in the questionnaire based on their true and genuine beliefs and ideas.

Assessment and Evaluation

Assessment and evaluation has been conducted based on two criteria in order to obtain the study results. The first criterion was to obtain and evaluate the students' views on the exams prepared using the CBCM technique. For this purpose, exams of Lessons 2, 3, 5, 6, 7 and 8 have been prepared using the CBCM technique. It was observed that student views concerning this aspect were at the "completely agree" level based on the answers provided to question 7, part 2 of the questionnaire shown on Table 1 and question 10, part 3 of the questionnaire shown on Table 2.

The second criterion was to obtain and evaluate students' views on the teaching material prepared. For this purpose, a questionnaire was developed that consisted of 3 parts.

Six questions in part 1 of the questionnaire considered demographic variables of students relating to gender (M/F), place of residence (home/state-sponsored student dormitory/private student dormitory/other), continuous computer access (Yes/No), continuous internet access (Yes/No), grade point average in the 9th grade (numeric information) and whether the student was using concept maps for the first time (Yes/No).

Part 2 of the questionnaire asks the students to provide their views on the features of the CBCM prepared for the microprocessors module by answering the 9 questions shown on Table 1. Findings based on the answers provided to the questions according to the Likert-type 1-to-5 rating scale (1: very poor, 2: poor, 3: average, 4: good, 5: very good) are provided in Table 1 as f, % and $\bar{X}$.

Eleven questions in part 3 of the questionnaire indicated in Table 2 aim to obtain the students' views on the teaching of the microprocessors module through WBDE using the CBCM technique. Questions were answered using the Likert-type 1-to-5 rating scale (1: completely disagree, 2: disagree, 3: undecided, 4: agree, 5: completely agree) and are provided in Table 2 as f, % and$\bar{X}$.

Questionnaire results and evaluations;

According to the results in part 1 of the questionnaire, demographic variables of students comprising the sample of the study are as follows:

- 27.3% female, 72.5% male,
- 54.5% reside at home, 45.5% reside at state-sponsored student dormitories,
- 24.2% have computer access at the place of residence while 75.8% do not have such access,
- 24.2% have internet access at the place of residence while 75.8% do not have such access, grade point average of 97% varies from 2 to 4,

81.8% have seen concept maps at that lesson for the first time while 18.2% have used concept maps at their lessons previously.

Table 1. *Questions and findings of part 2 of the questionnaire*

#	Questions asking students about their views on the features of CBCM	Student views (f)					Student views (%)					$\bar{X}$	Level of agreement
		1	2	3	4	5	1	2	3	4	5		
		Very poor	Poor	Average	Good	Very good	Very poor	Poor	Average	Good	Very good		
1	Have appropriate colors been used in the material?	0	0	3	**23**	7	0	0	9.1	**69.7**	21.2	**4.12**	A
2	Have appropriate text fonts been used in the material?	0	0	4	**17**	12	0	0	12.1	**51.5**	36.4	4.24	CA
3	Have appropriate sounds and animations been used in the material?	0	1	2	4	**26**	0	3.0	6.1	12.1	**78.8**	4.67	CA
4	Are materials easy to use?	0	0	3	8	**22**	0	0	9.1	24.2	**66.7**	4.58	CA
5	Do materials clearly indicate the lesson purpose?	0	0	2	13	**18**	0	0	6.1	39.4	**54.5**	4.49	CA
6	Does the presentation of the subjects using concept maps contribute to their better understandin g and learning?	0	0	1	4	**28**	0	0	3.0	12.1	**84.8**	4.82	CA
7	Do exams prepared with concept maps contribute to the better learning of the subjects?	0	0	0	6	**27**	0	0	0	18.2	**81.8**	4.82	CA
8	Are the concept maps in the material sufficient in explaining the subject?	0	0	6	8	**19**	0	0	18.2	24.2	**57.6**	4.39	CA
9	Are the concept maps in the material understandab le (intelligible)	0	0	2	14	**17**	0	0	6.1	42.4	**51.5**	4.45	CA

CA: Completely Agree A: Agree

Considering the findings in Table 1, which contains the results of part 2 of the questionnaire, the students' views correspond to the level "good" for questions 1 and 2 and to the level "very good" for the other questions. According to the results of $\bar{X}$, the levels to which the students agree with answers offered by the questions are "agree" for question 1 and "completely agree" for other questions.

Considering the findings in Table 2, which contains the results of part 3 of the questionnaire, it can be seen that the students' views correspond to "agree" for questions 2, 6 and 11 and to "completely agree" for other questions. According to the results of $\bar{X}$, the levels to which the students agree with answers offered by the questions according to the Likert-type 1-to-5 rating scale are "agree" for questions 6 and 11 and "completely agree" for other questions.

The significance of the responses to questions in part 2 of the questionnaire in consideration of the students' demographic profiles was tested using the t-test reliability analysis. Because the significance level (p) values varied from 0.066 to 0.904, which is greater than 0.05, it can be concluded that there is no significant variation among student responses to questions in part 2 of the questionnaire based on the differences in the students' demographic profiles. The significance of the responses to questions in part 3 of the questionnaire in consideration of the students' demographic profiles was tested using the t-test reliability analysis. Because the significance level (p) values varied from 0.329 to 0.928, which is greater than 0.05, it can be concluded that there is no significant variation among student responses to questions in part 3 of the questionnaire based on the differences in the students' demographic profiles.

RESULTS

In this study, concept maps were designed using the CBCM technique for the microprocessors module of the FIT course relating to the IT field. The concept maps were taught to the students via a WBDE platform. The contribution of the concept maps to education and their effect on students was studied. In the scope of the study, the concept map method has been used in both subject presentation and evaluation and has enjoyed popularity among the students.

According to the survey results, the students have most eagerly agreed with the propositions claiming that "presentation of subjects with the use of concept maps contributes to better learning and understanding of those subjects" and that "exams prepared using concept maps contribute to the learning of the subjects". Moreover, concerning views on CBCM, the students most eagerly agreed with the propositions "I believe that CBCM would be useful in studying for exams" and "Lessons are more enjoyable if taught using CBCM".

It has also been determined that demographic variables of the students do not have an impact on their views concerning the teaching material and CBCM. These results lead us to conclude that preparation of modules in TVE fields using CBCM and their teaching via WBDE is a method that would likely improve the students' performance.

Table 2. *Questions and findings of part 3 of the questionnaire*

#	Questions that address the students' views on teaching with WBDE using the CBCM technique	Student views (f)					Student views (%)					$\overline{X}$	Level of Agreement
		1	2	3	4	5	1	2	3	4	5		
		Completely Disagree	Disagree	Undecided	Agree	Completely Agree	Completely Disagree	Disagree	Undecided	Agree	Completely Agree		
1	Have CBCM helped you to better learn complicated subjects?	1	0	2	12	**18**	3.0	0	6.1	36.4	**54.5**	4.39	CA
2	Have CBCM helped you build connections between the subjects and sub-subjects?	0	0	3	**19**	11	0	0	9.1	**57.6**	33.3	4.24	CA
3	Have figures and graphics used in CBCM made abstract concepts clearer and better understandable?	1	0	3	8	**21**	3.0	0	9.1	24.2	**63.6**	4.45	CA
4	Do you believe that CBCM would be useful when studying for exams?	0	0	1	9	**23**	0	0	3.0	27.3	**69.7**	4.67	CA
5	Do lessons taught using CBCM tend to be more enjoyable?	0	1	0	10	**22**	0	0	3.0	30.3	**66.7**	4.61	CA
6	Have CBCM increased your interest in the FIT course?	2	0	1	**17**	13	6.1	0	3.0	**51.5**	39.4	**4.18**	A
7	Have CBCM made it possible you to repeat a subject in a shorter time?	1	0	4	6	**22**	3.0	0	12.1	18.2	**66.7**	4.45	CA
8	Do you believe that CBCM are simple and easy to understand?	1	0	2	13	**17**	3.0	0	6.1	39.4	**51.5**	4.39	CA
9	Has the preparation of CBCM as animations increased your interest in concept maps?	1	0	4	13	**15**	3.0	0	12.1	39.4	**45.5**	4.24	CA
10	Would you recommend using questions involving the completion of concept maps in exams?	2	1	1	9	**20**	6.1	3	3.0	27.3	**60.6**	4.33	CA
11	Will you now make your own concept maps when studying for your courses?	1	1	1	**13**	8	3.0	3	30.3	**39.4**	24.2	**3.79**	A

CA: Completely Agree A: Agree

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