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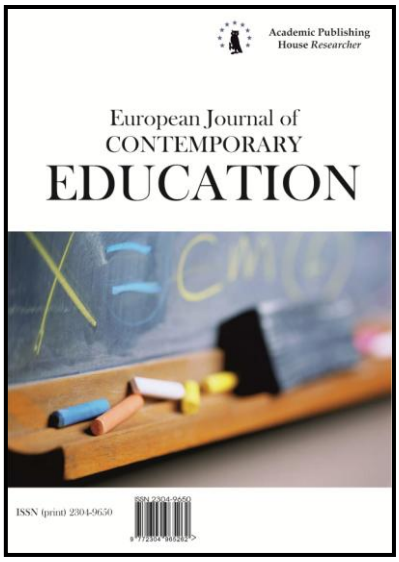

A Study to Determine the Contribution made by Concept Maps to a Computer Architecture and Organization Course

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Abstract

Concept mapping is a method of graphical learning that can be beneficial as a study method for concept linking and organization. Concept maps, which provide an elegant, easily understood representation of an expert's domain knowledge, are tools for organizing and representing knowledge. These tools have been used in educational environments to better connect the relationships among theory and practice as well as among other concepts covered in a course. They also help the learners build relationships between previous knowledge and newly introduced concepts, encouraging meaningful learning rather than rote learning.

The overall interactions among hardware, computer basics, computer functions and etc., used to be simple and transparent enough for understanding computer systems. Nevertheless the modern computer technologies have become increasingly more complex which makes it very difficult to understand the whole system of the computers. This study is an analysis of the contribution made by concept maps to a Computer Architecture and Organization course (CAO). For a period of one semester, students were asked to prepare concept maps that they were later allowed to use when revising for their final exam. The students' success in the exam was then evaluated and their attitudes towards the course, the concept maps and the questions on them were surveyed and analyzed. The results lead to the conclusion that not only did concept maps make a positive contribution to the students' overall success during the course, they also helped with their exam preparation.

Keywords: concept map, computer architecture and organization, survey, SPSS.

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Introduction

A concept map is a two dimensional diagram in which concepts and the links between them are displayed graphically, showing their interconnected relationships under a wider concept heading (Novak *et al.*, 1984; Kinchin *et al.*, 2000). A concept map can be described as a kind of planning tool for organizing and representing knowledge to show students what concepts need to be studied and how connections can be formed between them (Demirel, 2002).

Concept maps are a form of metacognitive strategy used to identify what students know (Novak, 1990) and a graphic illustration of how particular concepts are interconnected. These concepts are not described with the use of sentences; they are formed through connections. The maps aid the learning of concepts in an easy and lasting way, allowing both the student and the teacher to focus on a special topic and commit it to memory. Furthermore, the connections between the concepts can be understood visually and after the learning process is complete, the maps serve as a summary of what has been learned.

Concept maps create a distance between the student and memorization, making the learning experience more permanent. Using these maps as a teaching-learning strategy builds a bridge between the foci of *how people learn* and *meaningful learning,* combining close connections with creative learning.

They not only allow us to form connections with our existing knowledge but also to display a relationship between previously unrealized concepts. Many teachers and students have said that as a result of this method they have formed connections that they had not previously comprehended. In this respect, a concept map is a creative activity that encourages creativity (Novak and Gowin, 1994).

CAO is one of the basic Information Technology courses and has a wide curriculum base; CAO subjects involve numerous related technological concepts. These concepts are constantly used during students' education and future careers. Very often students can find learning these varied and new concepts difficult and if these concepts are not learned correctly it may not only result in flawed learning but also impact negatively on other subjects related to these concepts (Stallings, 2000).

In the literature, the general use of concept maps as a learning tool in the area of Information Technology has been well researched (Chang *et al.*, 2001; Tsai *et al.*, 2001; Keppens and Hay, 2008; Roy, 2008; Tokdemir and Cagiltay, 2010; Charsky and Ressler, 2011; Huang *et al.*, 2012; Kuk et al., 2012; Larraza-Mendiluze and Garay-Vitoria, 2012; Uğuz and Aydoğan, 2014). The studies frequently draw attention to the following areas: Web and computer-based concept mapping for learning, concept map assessment for teaching computer programming, the use of game based concept mapping to learn basic concepts for computing science courses.

The most important aspect of this study, and one that makes it different from the others, is that for the CAO course, concept maps are shown to be a useful tool for exam revision. In addition, it identifies the contribution made by concept maps to the CAO course, the overall success of the students, and how the students' attitudes improved towards this course. The current analysis includes the provision of concept maps, the final exam questions, and data collection tool; the sample of the study, reliability and validity studies, analysis of data parts are defined in the method section. The basic survey findings are discussed in the results section and elaborated in the discussion and conclusion sections.

Method

The study was initiated with a training period one semester prior to the CAO course, in which the students were given information about how to prepare and use concept maps. It was then included as part of the CAO syllabus, which lasted for a period of 14 weeks. During the module, the students were asked to prepare concept maps, which they would then be allowed to use as part of their final exam revision. Lastly, after the final exam, which also involved questions relating to the concept maps, the students were asked to complete a survey, to be used as a data collection tool. The answers given to the exam questions and the students' assessments, gained through the survey, were analyzed and evaluated using scientific methodology.

Preparation of Concept Maps

The CAO course program consisted of seven sections, including: An Introduction to the Subject, Computer Evolution and Performance, General Computer Functions and Internal Connections, Cache Memory, Internal Memory, External Memory and Input/Output. Each section was allocated to two separate student groups, each consisting of two students, for the preparation of concept maps. From the prepared maps, three that were found to be the most comprehensive, in terms of their visual and relational connections (4, 6 and 7), were used in the preparation of the final exam questions. In addition, the maps distributed to the students for revision a week before the final exam were published on the web site.[*]

Preparation of the Final Exam Questions

The final exam consisted of 30 multiple-choice questions, 18 of which were associated with the concept maps. The concept maps relating to parts 4, 6 and 7 were distributed to the students and six questions from each section were given in the exam.

Preparation of Data Collection Tool (Survey)

In order to determine the students' attitudes to studying with concept maps, a form was prepared that consisted of two surveys. Attitudes were determined by their opinions of the expressions set to measure attitudes and not by a question/answer method.

In the first survey, there were 18 expressions used to ascertain the students' attitudes on the CAO course. The survey opinions were obtained through a five-point Likert scale (I totally agree, I agree, I am indecisive, I do not agree and I totally do not agree).

In the second survey, 17 expressions were used to assess the students' opinions on the contribution made by using concept maps as revision material for the final exam, and their exam success. Opinions on the 11 questions in the survey were obtained using a five-point Likert scale (I totally agree, I agree, I am indecisive, I do not agree and I totally do not agree) and the opinions on the four expressions that were determined as, a lot, medium, not much and opinions on two questions through a *yes* or *no* rating.

This research was a field study of a descriptive nature; descriptive methodology is a research approach that aims at determining a situation, past or presents (Karasar, 2012).

The Sample of the Study

The study sample consisted of three groups of 129 students, who took part in the CAO course at the Technical Education Faculty of the Electronic Computer Education Department at Suleyman Demirel University.

Reliability and Validity Studies

First, in order to obtain meaningful results, the reliability and validity of the data collection tools used in the study was analyzed. The reliability of the measurement tool is an "indication of to what extent the measurement tool determines the feature or features" (Tekin, 2000). While the reliability of a measurement tool can be calculated using various methods, the one used most widely is the internal consistency method. In this study, the Cronbach's Alpha Coefficient (Özdamar, 2002) was used to test the reliability of the scale. The alpha coefficient of the applied measurement tool was 0.732, showing that the measurement tool was very reliable.

Validity is used to determine whether a scale can measure the intended feature. After the reliability of the scale has been determined, in order to establish to what extent the scale in question measures the intended content, a convergent and discriminant validity analysis has to be conducted (Lamm, 2002).

In order to make content validity possible, during the preparation of the expressions to measure the attitudes in the surveys, relevant experts were consulted to increase the intelligibility of the expressions.

The convergent and discriminant validity of the scale had to be initially controlled using item analysis and then using explanatory factor analysis. First, a correlation matrix of the scale relating to the expression factors was prepared. Following this, in order to determine the convergent and

[*] http://tef.sdu.edu.tr/assets/uploads/sites/158/files/bmokavramharitalari-09112015.pdf

discriminant validity, a correlation of the variables and dimensions occurring within the same expression was analyzed. An explanatory (descriptive) factor analysis was also used as a validity test for the expressions used in the survey form.

In order to be able to apply an explanatory factor analysis, certain prerequisites must be met. First, the number of surveys subject to factor analysis needs to be larger than the number of expressions. In the study, since the number of students undertaking the survey was 129 and the number of total expressions in the survey was 41, this prerequisite has been met. The second prerequisite required that the KMO Kaiser-Meyer-Olkin Measure of Sampling Adequacy sample efficiency measure and the Bartlett's Test of Sphericity were of a sufficient level (Field, 2009). Analysis showed the KMO sample efficiency measure to be 0.948 and the Bartlett's Test of Sphericity, 4526.548; with p<.000. From these results it was seen that the sample was sufficient and meaningful expressions could be obtained from the research data.

Analysis of Data

The opinions used in the data collection for the scale provided by the sample were analyzed using the SPSS 16.0 statistical package program. To analysis the data frequency (f) and percentage (%), the values were calculated.

Findings

The findings of the study consisted of the analysis of the answers given to the questions relating to the concept maps in the final exam questions and the analyses of the data obtained from the first and second surveys.

Results of Questions about Concept Maps used in the Final Exam

The section numbers of the questions associated with concept maps, together with the number of correct answers given to these questions and their percentages, are shown in Table 1. The reason for the number of correct answers given to questions 9, 12 and 14 being much lower than the others is that their answer choices consisted of contradictory and very closely related concepts. Otherwise, it can be seen that the number of correct answers is quite high.

Table 1. Answers given to questions related to concept maps

#Question	#Section	# of students who gave correct answers (N=129)	%
7	7	114	87
9	4	46	35.1
11	4	128	97.7
12	4	43	32.8
13	4	90	68.7
14	4	50	38.2
15	4	86	65.6
16	6	104	79.4
21	6	70	53.4
22	6	75	57.3
23	6	85	64.9
24	6	80	61.1
25	6	79	60.3
26	7	69	52.7
27	7	89	67.9
28	7	88	67.2
29	7	53	40.5
30	7	72	55

Outcome of the First Survey in which Students' Attitudes towards the Course were established

The students were indecisive about whether they liked the course, felt bored while studying for it, or were enjoying the course. However, they stated their negative opinions on learning more with CAO subjects. They remained indecisive about being anxious about the CAO course, the number of course hours allocated for the course and allocating a majority of their time for this course. While the students said that the CAO course was not necessary for their education, they remained unsure about whether or not they would take this course if it were not obligatory. This shows that the students' were unable to be clear in their attitudes towards this course.

The students, who had indicated that the course would not be any more enjoyable if it were taught using an applied approach, remained indecisive about using the CAO course in their daily lives. The students with this view claimed that they did not get tired while listening to the lecture, did not later forget what they learned from the lecture and were not able to associate the course topics with those of other courses. However, the CAO course is directly related to other vocational courses and it is an accumulation of the fundamental knowledge of these courses.

While the students said that they have not been able to differentiate the different parts of the CAO course from each other, they believed that they were able to make up for their deficiencies in the other courses with the help of this course.

The course is taught during the sixth semester and when it was asked how the syllabus would have benefited them if it had been taught in a previous semester, the students did not think that the course would have been more beneficial. In addition, they believed that the course would not be more beneficial even if changes were made to the teaching style.

As a result of the analysis of the first survey, due to reasons such as the high number of concepts in the CAO course curriculum, their complexity, the high number of concepts and the relationships between them and their being easily forgotten, it was observed that the students were not able to develop a clear attitude towards the CAO course.

Outcome of the Second Survey in which Attitudes Related to the Contribution made by the Concept Maps to the Success in the Final Exam:

Have the concept maps reduced the study time of students for the exam?

The question "How much did you study for the CAO course's final exam?" and the opinions given by the students for the expressions, "Concept maps reduced my preparation time for the exam" and the distribution of frequency and percentage can be seen in Table 2.

Table 2. The relationship between the students' preparation time for the final exam and the concept maps not reducing their preparation time for the exam

				Concept maps have reduced my preparation time for the final exam		
		Total (f)	Percentage %	Very much	Medium level	Not much
How much did you spend to get prepared for the final exam?	1-2 hours	9	7.0	1	3	5
	3-5 hours	51	39.5	4	20	27
	6-10 hours	37	28.7	4	18	15
	11-15 hours	13	10.1	3	3	7
	15 hours and more	19	14.7	2	6	11
	Total (f)	129	100.0	14	50	65

Eighty-eight of the students stated that their preparation time for the final varied between three and ten hours. Whether or not the concept maps affected the preparation time for the final exam was determined by 80 of the students in this group, in that it did not reduce the study time in the *medium-not much* level and only eight of them said that it reduced the study time *very much*. As a result, it can be seen that concept maps do not significantly reduce their preparation time for

the exam. However, this supports the theory that concept maps may help retain knowledge in the subject's memory for a longer period and its use in revision and for solidifying abstract concepts.

What are the students' views on how much concept maps contributed to their final exam revision time?

Table 3 shows that eight of the expressions in the survey relate to this.

Table 3. Students' views on how much concept maps contributed to their final exam revision time

Percentage (%)	Expressions
35.7	They had opportunities to share the concept maps they prepared, analyzed various different concept maps, use them for exam revision
31.8	Homework facilitated their exam preparation
7	They used all sections of the concept maps while preparing for the exam
51	Since they were in command of the subject related to the concept map they prepared, they were able to spend more time studying for other subjects
45.7	They more easily understood subjects that had concept maps
31	As a result of concept maps they were able to solidify the abstract concepts included in the CAO course
25.6	Due to the concept maps it was easier for them to learn the topics covered in the course

As a result of the concept maps they prepared, the students were able to simplify the revision for their final exam and make it efficient and productive. In addition, sharing the concept maps among themselves meant that they were able to compensate for their knowledge deficiencies and understanding due to diversity in the study process.

What are the students' views in terms of whether or not they understood the questions associated with the concept maps in the final exam?

There are two expressions in the survey relating to this. A total of 56.6% of the students chose "very much" for the expression "In the exam there were questions about the subjects illustrated in the slides used as course documents"; 31.8% stated "medium" and 10.9% stated "not much" as the answer to the same expression. 21.7% of the students stated "very much" for the expression. "There were questions that were illustrated in the concept maps in the exam"; 45% stated "medium" and 32.6% stated "not much" as the answer to the same expression.

This result shows that the concept maps circulated amongst the students did not steer them towards memorization and although the questions were not directly formed from the concept maps, 60.26% of the students gave correct answers to these questions.

What are the students' views on understanding the speed with which students have answered questions relating to concept maps?

There are two expressions in the survey for this purpose. While 24.8% of the students stated "I agree" for the expression "I have easily answered the questions about the components supported by concept maps"; 30.2% of the students stated "I agree" for the expression "I have been able to answer certain questions in the exam more quickly because I knew them from the concept maps."

What are the students' views on the use of concept maps in exams for other subjects?

Altogether, 29.5% of the students said, "They thought about using the concept maps while revising for exams in other subjects."

What are the general attitudes of the students who prepared the concept maps of the sections associated with the concept maps in the final exam in the surveys?

Only three out of seven sections that constituted the CAO curriculum were used in the final exam to prepare the 18 questions associated with concept maps. Nine of the 129 students who were given the survey prepared the concept maps for the fourth section, ten prepared the content maps for the sixth section and 12 prepared the content maps for the seventh section. Of these 31 students, in the range of 78-82% said "I agree" for the expressions in the survey and expressed that revising for the final exam using concept maps significantly contributed to their success in the course.

Discussion and Conclusion

This purpose of this study was to establish the contribution made by concept maps, prepared by the students during final exam preparation, for the CAO course. An analysis was conducted establishing to what extent the concept mapping method could be effective in terms of teaching these types of course, in which there are many concepts and much conceptual confusion.

When the students' opinions to the course in the first survey were analyzed it could be seen that they remained indecisive in their general attitude towards this course. However, it was observed that the concept maps distributed between them to revise for the final exam increased their success in the course, their understanding of the course and their interest in the course. In fact, it can be understood from the analysis of the surveys that the actual preparation of the concept maps further increased their success. The students had not realized that the questions they had answered easily (and mostly correctly) were those associated with the concept maps. Therefore, one of the study's objectives, to strengthen the relationships between the concepts and removing conceptual confusion, correctly learning concepts and information by making these concrete through the content maps, was achieved.

One of the expressions achieved as a result of the study was that the students thought that they could have received higher scores if they had been given content maps prior to the mid-term and their wish to use content maps while studying for exams in other subjects.

It has been established in this study that the content maps made a positive contribution not only in the teaching of the course but also in the students' success rate when they were used for other exams.

Since content maps are an efficient teaching-learning strategy it can be considered that the use of this method may be beneficial both in course teaching and studying. In addition, it can be effective when learning a subject containing many concepts, which can result in conceptual confusion.

References

1. Chang, K. E., Sung, Y. T., & Chen, S. F. (2001). Learning through computer-based concept mapping with scaffolding aid. Journal of Computer Assisted Learning, 17(1), 21-33.
2. Charsky, D., & Ressler, W. (2011). "Games are made for fun": Lessons on the effects of concept maps in the classroom use of computer games. Computers & Education, 56(3), 604-615.
3. Demirel, Ö. (2002). Öğretimde planlama ve değerlendirme öğretme sanatı. Pegem A Yayıncılık. 275s.
4. Field, A. (2009). Discovering statistics using SPSS. Sage publications.
5. Huang, H. S., Chiou, C. C., Chiang, H. K., Lai, S. H., Huang, C. Y., & Chou, Y. Y. (2012). Effects of multidimensional concept maps on fourth graders' learning in web-based computer course. Computers & Education, 58(3), 863-873.
6. Karasar, N. (2012). Bilimsel araştırma yöntemi: kavramlar, ilkeler, teknikler. Nobel Yayın Dağıtım.
7. Keppens, J., & Hay, D. (2008). Concept map assessment for teaching computer programming. Computer Science Education, 18(1), 31-42.
8. Kinchin, I. M., Hay, D. B., & Adams, A. (2000). How a qualitative approach to concept map analysis can be used to aid learning by illustrating patterns of conceptual development. Educational research, 42(1), 43-57.
9. Kuk, K., Rancic, D., Spalevic, P., Trajcevski, Z., & Micalovic, M. (2012). Use game based interactive multimedia modules to learning basic concepts on courses for computing science. Przeglad Elektrotechniczny, 88, 150-153.
10. Lamm, R. (2002). The interpersonal relationship in doctoral supervision. La Trobe University.
11. Larraza-Mendiluze, E., & Garay-Vitoria, N. (2012). A comparison between lecturers' and students' concept maps related to the input/output topic in computer architecture. In Proceedings of the 12th Koli Calling International Conference on Computing Education Research (pp. 57-66). ACM.
12. McGowen, M., & Tall, D. (1999). Concept Maps & Schematic Diagrams as Devices for Documenting the Growth of Mathematical Knowledge.

13. Novak, J. D., Bob Gowin, D., & Johansen, G. T. (1983). The use of concept mapping and knowledge vee mapping with junior high school science students. Science education, 67(5), 625-645.

14. Novak, J. D. (1990). Concept maps and Vee diagrams: Two metacognitive tools to facilitate meaningful learning. Instructional science, 19(1), 29-52.

15. Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. Cambridge University Press.

16. Özdamar. K. (2002). Paket programlar ile istatistiksel veri analizi. Kaan Kitabevi, Eskişehir, 535.

17. Roy, D. (2008). Using concept maps for information conceptualization and schematization in technical reading and writing courses: A case study for computer science majors in Japan. In Professional Communication Conference, 2008. IPCC 2008. IEEE International (pp. 1-12). IEEE.

18. Stallings, W. (2000). Computer organization and architecture: designing for performance. Pearson Education India.

19. Tekin, E. (2000). Karşılaştırmalı tek-denekli araştırma modelleri. Ankara Üniversitesi Eğitim Bilimleri Fakültesi Özel Eğitim Dergisi, 2(04).

20. Tokdemir, G., & Cagiltay, N. E. (2010). A concept map approach for introduction to computer engineering course curriculum. In Education Engineering (EDUCON), 2010 IEEE (pp. 243-250). IEEE.

21. Tsai, C. C., Lin, S. S., & Yuan, S. M. (2001). Students' use of web-based concept map testing and strategies for learning. Journal of Computer Assisted Learning, 17(1), 72-84.

22. Uguz, S., & Aydogan, T. (2014). Effects of Using The Computer Based Concept Maps in The Web Based Distance Education for Processors Courser. Çukurova University. Faculty of Education Journal, 43(2), 125.

23. Uğuz, S. (2008). İşlemciler modülünün web tabanlı uzaktan eğitim ile kavram haritası tekniği desteğiyle öğretilmesine örnek bir uygulama (Doctoral dissertation, SDÜ Fen Bilimleri Enstitüsü).

24. Yalın, H. İ. (2002). Öğretim teknolojileri ve materyal geliştirme. Nobel.