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A comparison between the traditional lecture method and concept mapping method on teaching boolean algebra

INTRODUCTION

In education implemented throughout the history of humanity, all kinds of information and social values intended to be transferred to the young generation are realized by teachers. The higher quality of teaching, the more achievement of student is. To achieve the goal of teaching and learning, the teacher must adopt effective teaching and learning methods in education. The teacher has many options to choose from different methods designed specifically for teaching and learning.

Purpose of the Study

The purpose of this research presented here is to investigate the effects of using concept maps on student achievement at teaching 'Binary System and Boolean Algebra'.

Significance of the Study

Nowadays the information easy to reach but to keep in mind and to reach new findings and synthesis are quite difficult. In educational process for effective learning, the teaching materials for the learning purpose should be comprehensible and appropriate for the students. Furthermore, the learners are expected to construct the concepts and relations of the learning materials so as to achieve the desired learning objectives. Concept mapping is a method using graphs for representing knowledge in a structure according to different levels of abstraction and inclusion. The method has been widely applied in many disciplines and various educational levels. This learning environment is intended to guide the learners toward general understandings of the subject they have to learn.

In the study of mathematics, students need opportunities to deliberate upon their mathematical understandings. This mathematical concept mapping project involves students submitting concept maps created at the conclusion of instructional units to elicit further collaboration with high school students. Concept maps are effective methods of assessing student knowledge, comprehension, synthesis, and evaluation. This project provides students a platform for illustrating and sharing their mathematical proficiency with their compeers. Submitted concept maps will be compiled into the standard mathematical categories enabling teachers to quickly establish maps targeting current studies. Opportunities abound for teachers to further utilize concept mapping in their classes for cooperation, critical thinking comparisons, and deeper assessments.

Problem Statement of the Study and Research Questions

The purpose of this study is to investigate whether concept mapping can motivate students to continue learning academic subjects, after instruction has ended. In particular, this is a study about motivating students to continue learning Boolean algebra from constructing concept maps that presents complex statements and expressions requiring mathematic knowledge and skills to learn. That is, the focus is on how a concept mapping may be able to promote continuing motivation to learn mathematics. Thus, our problem sentence can be stated as "What are the effects of using concept maps on student achievement in teaching 'Binary System and Boolean Algebra'?"

The following are the research questions for this dissertation:

1. Is there any significant difference between pre-test scores of experimental and control group?
2. Is there any significant difference between post-test scores of experimental and control group?
3. Is there any significant difference between pre-test and post-test scores of control group?
4. Is there any significant difference between pre-test and post-test scores of experimental group?

5. Is there any significant difference between the difference of average scores of pre-test and post-test of experimental group and control group?

Assumptions and Limitations

- Achievement tests and activities will be at appropriate level of the students.
- Variables that may affect the research are assumed to affect the experimental and control groups in the same way.
- Experimental and control group students put forward their real power to answer the questions given with the aim of measure.
- The research will take place in Engineering Faculty of Suleyman Demirel University in Almaty and 40 second year students will participate in that research.
- The prepared questions and activities will be limited to the topic of 'Binary System and Boolean Algebra'.

DEFINITIONS

Algebra: Algebra can be defined as (S. Wagner & S. Parker. 1999) a language for describing actions on, and relationship among, quantities. As with any language difficulties may arise from feature of the language itself or in translating from one language to another. Within the language of algebra, most linguistic difficulties are related to variables and expressions; most translation difficulties arise in translating word problems into equations. Because we use two distinct symbol systems (letters and numbers) together in algebra, and because these systems follow different rules, we gain some us some economy of the notation, but at the expense of possible confusion. Since the errors happen most frequently at the turning points of the knowledge, when teaching new knowledge, we should emphasize its relationship to and difference with the old knowledge, to show students how it is derived from the old knowledge and what the development is.

Boolean Algebra

"The English mathematician George Boole (1815-1864) sought to give symbolic form Aristotle's system of logic. Boole wrote a treatise on the subject in 1854, titled An Investigation of the Laws of Thought, on Which Are Founded the Mathematical Theories of Logic and Probabilities, which codified several rules of relationship between mathematical quantities limited to one of two possible values: true or false, 1 or 0. His mathematical system became known as Boolean algebra" (Kuphaldt,T.R.2006).

Concept: In general usage the term mainly denotes 'idea' or 'notion' (J. Gould and W. Kolb, 1964). It is envisaged as an abstract or psychological thing presupposing conscious minds which at least potentially 'have' the concept, i.e., understand it, operate with it, apply it, etc. In philosophy and the social sciences (and other sciences too) concepts enter as the most general tools of inquiry as such and as the content or object of some specific inquiries, notably in comparative studies.

Concept Map: Concept maps were developed in 1972 (Novak&Canas, 2008) in the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science. It is a kind of teaching and learning method based on Jean Piaget and David Ausebel's Cognitive learning theory (Hamachek, 1986). It's been defined by Novak&Govin (1984) as "Concept maps are intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit. In its simplest form, a concept map would be just two concepts connected by a linking word to form a proposition. A concept map is a schematic device for representing a set of concept meanings embedded in a framework of propositions".

According to Novak&Canas (2008) a concept map has five basic elements:

- Hierarchical structure: Used to show the relative importance of ideas. Most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below.
- Concepts: Usually nouns representing objects or events, and are enclosed in ovals or boxes.

- Propositions: Statements about some objects or events in the universe, either naturally occurring or constructed.
- Cross links: Connecting lines linking two concepts.
- Linking words: Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts.

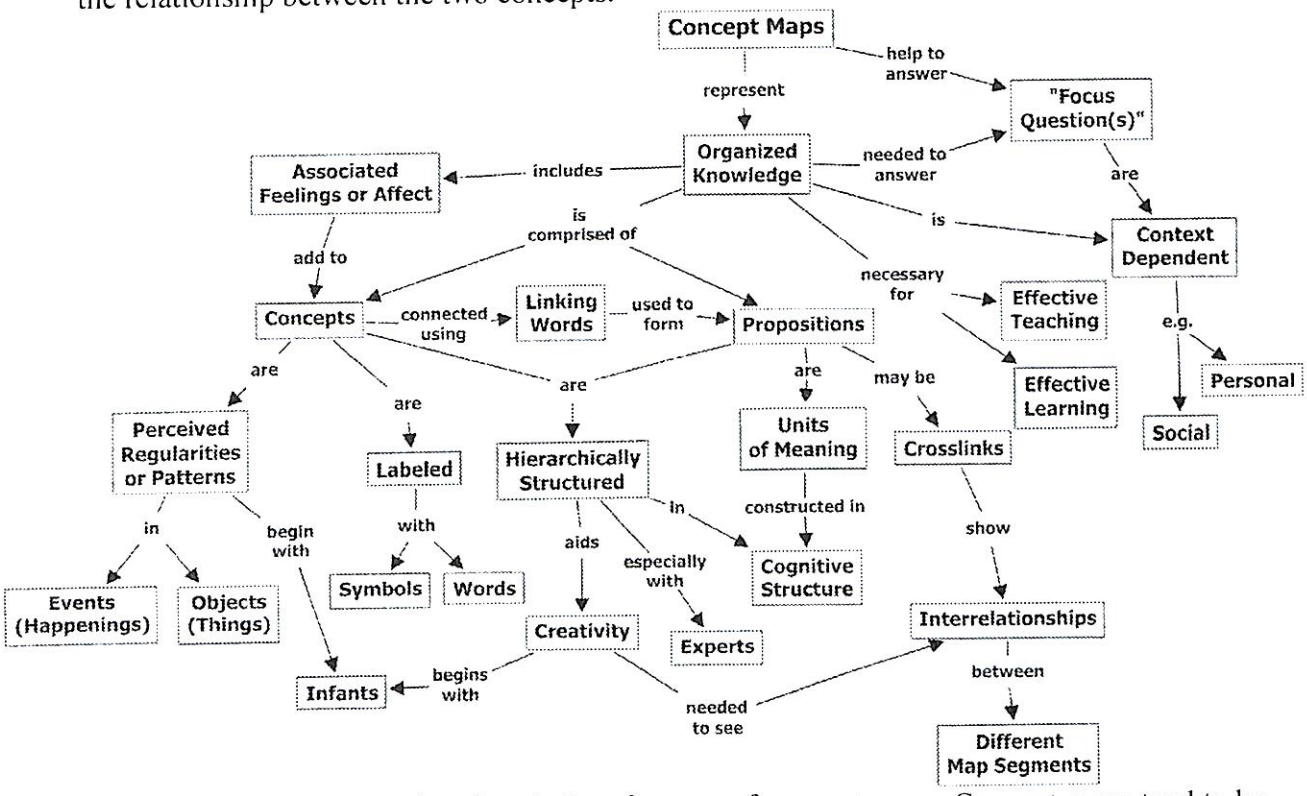

Figure 1- A concept map showing the key features of concept maps. Concept maps tend to be read progressing from the top downward.

METHODOLOGY

This section explains the methodology and methods that will be used in the study of learning Boolean algebra with concept mapping. The research model, the universe and the sampling, data collection and data analysis are also emphasized.

Research Model

This research is based on some experiments and observations. Two groups are chosen randomly from the 8 group of second year students of engineering faculty. At the beginning of the research a pre-test is applied to experimental group and control group. Experimental group has been called Ex-Gr and control group has been called Co-Gr. Ex-Gr has been prepared in a teaching environment in which the concept mapping method has been applied. Co-Gr has been prepared in a teaching environment in which the traditional lecture method has been applied. At the end of the process a post-test is applied to both groups. Table 2.1 given below shows the pattern of the two groups.

Table 2.1. The pattern of the groups in research

Groups	Preliminary measurements	Experimental procedure	Final measurements
Ex-Gr	Pre-test	Concept mapping method	Post-test
Co-Gr	Pre-test	Traditional lecture method	Post-test

Sample Selection

Sample groups have been chosen from second year students of Department of IT of Engineering Faculty in Suleyman Demirel University in Almaty.

Table 2.2. Information about sample groups

Groups	Number of students
Ex-Gr	20
Co-Gr	20
Total	40

The two groups have been chosen randomly, they have not been equalized, and they have been accepted as formed by the department.

The research process took a time of three weeks to apply the method on two groups. Some measurement tools, methods and steps are given below.

Achievement Test

A) Purpose of the test: To determine the preliminary knowledge of the students about the given topic as a pre-test and to establish the gains of the students after the application of two methods as a post-test.

B) Properties of the test: The test has been prepared by the researcher in accordance with the aims and procedures of the main course book of "Digital Design (4th Ed.) - M. Morris Mano, Michael D. Ciletti. Prentice-Hall of India 2008. Besides the course book, some test books and some test banks in internet sites related with that topic has also been used.

The test includes 25 questions and the questions are gathered under three chapters.

The test was prepared so that could be answered in 60 min.

The test was given to 40 students before the process as a pre-test and after the process as a post-test.

Research Procedure

This research is done in Suleyman Demirel University, Almaty, in 2010-2011 education year during the second semester. During the research process the topic of 'Binary System and Boolean Algebra' was studied. Two groups were chosen randomly from second year students of Department of IT and one of the groups was chosen as control group, the other one was chosen as experimental group.

Before applying the teaching methods, the pre-test was applied to both groups. The data obtained from the results of the pre-test were used to determine the equalization of the group with t-test.

After applying the pre-test the pre-prepared lecture notes about the topic of 'Binary System and Boolean Algebra' were presented as the traditional lecture method in Co-Gr, and the problems related with the subject were solved in the practice time. Before the presentation of the subject, some information about the concept mapping method was given to Ex-Gr, and the same topic was presented with the concept mapping method in Ex-Gr. Then besides the problems solved in Co-Gr, some concept maps about the topics were formed by Ex-Gr students in the practice time. This process lasted for 12 class hours for each group. At the end of the process, the test that was used as a pre-test, was given again to students as a post-test. The data obtained from the results of the post-test were analyzed with t-test.

Application of Concept Mapping Techniques

Concept mapping method was applied on Ex-Gr. The concept maps about the subject were prepared by the computer program Microsoft Visio. During the six of practice times, the concept maps about the presented topics were prepared by the teacher and were given to the students as unfinished form. Students were asked to fill the missing parts in the map. Concept maps created by the students were evaluated and the mistakes detected were corrected together with the teacher in the class.

DATA ANALYSIS AND DISCUSSIONS

In this section, the data obtained during the research was analyzed and presented so that the problems and sub problems established at the end of the first section were explained clearly.

Sub-problem: Is there any significant difference between pre-test scores of experimental and control group?

The t-test has been used to find out whether there is a significant difference between pre-test scores of experimental and control group, and the results were shown by Table 1 given below.

Table 1: Comparison of the pre-test scores of experimental and control group

Test type	Group	N	Average (25)	Standard deviation	t	Degrees of freedom	P
Pre-test	Ex-Gr	20	9.20	1.74	0.2	38	0.84
	Co-Gr	20	9.35	2.78			

According to the table given above, it is seen that the pre-test results of the experimental group ($\overline{X}$ = 9.20) is lower than the pre-test results of the control group ($\overline{X}$ = 9.35). But statistically, there is no significant difference between pre-test scores of experimental and control group (P>0.05). In other words, pre-knowledge of experimental and control group with respect to the given topics are approximately the same.

Sub-problem: Is there any significant difference between post-test scores of experimental and control group?

The t-test has been used to find out whether there is a significant difference between post-test scores of experimental and control group, and the results were shown by Table 2 given below.

Table 2: Comparison of the post-test scores of experimental and control group

Test type	Group	N	Average (25)	Standard deviation	t	Degrees of freedom	P
Post-test	Ex-Gr	20	20.15	1.81	5.33	38	<0.0001
	Co-Gr	20	16.70	2.25			

According to the table given above, it is seen that the pre-test results of the experimental group ($\overline{X}$ = 20.15) is higher than the pre-test results of the control group ($\overline{X}$ = 16.70). Statistically, there is a significant difference between pre-test scores of experimental and control group (P<0.05). In other words, the gains of experimental and control group with respect to the given topics are different from each other. It means this significant difference is in favor of the experimental group. Hence it is determined that the concept mapping method applied to the experimental group increased the success drastically.

Sub-problem: Is there any significant difference between pre-test and post-test scores of experimental group?

The t-test has been used to find out whether there is a significant difference between pre-test and post-test scores of experimental group, and the results were shown by Table 3 given below.

Table 3: Comparison of the pre-test and post-test scores of experimental group

Group	Test type	N	Average (25)	Standard deviation	t	Degrees of freedom	P
Ex-Gr	Pre-test	20	9.20	1.74	19.5	38	<0.0001
	Post-test	20	20.15	1.81			

According to the table given above, it is seen that the post-test results of the experimental group ($\overline{X}$ = 20.15) is higher than the pre-test results ($\overline{X}$ = 9.20). Statistically, there is a significant difference between post-test and pre-test scores of experimental group (P<0.05). As seen the gains of experimental and control group with respect to the given topics are different from each other. In other words, after applying of the concept mapping method, this significant difference was found out as in favor of the experimental group. Hence it is determined that the concept mapping method applied to the experimental group increased the achievement of the students significantly.

Sub-problem: Is there any significant difference between pre-test and posttest scores of control group?

The t-test has been used to find out whether there is a significant difference between pre-test and post-test scores of the control group, and the results were shown by Table 4 given below.

Table 4: Comparison of the pre-test and post-test scores of experimental group

Group	Test type	N	Average (25)	Standard deviation	t	Degrees of freedom	P
Co-Gr	Pre-test	20	9.35	2.78	9.2	38	<0.0001
	Post-test	20	16.70	2.25			

According to the table given above, it is seen that the post-test results of the control group ($\overline{X}$ = 16.70) is higher than the pre-test results ($\overline{X}$ = 9.35). Statistically, there is a significant difference between post-test and pre-test scores of control group (P<0.05). That means traditional lecture method is also not so bad.

Sub-problem: Is there any significant difference between the difference of average scores of pre-test and post-test of experimental group and control group?

The t-test has been used to find out whether there is a significant difference between the difference of average scores of pre-test and post-test of experimental group and control group, and the results were shown by Table 5 given below.

Table 5: Comparison of the average scores of pre-test and post-test of experimental group and control group

Test type	Group	N	Average Diff	Standard deviation	t	Degrees of freedom	P
Average Diff.	Ex-Gr	20	10.95	1.90	3.92	38	0.0004
	Co-Gr	20	7.35	3.63			

According to the table given above, it is seen that the results of the experimental group ($\overline{X}$ = 10.95) is higher than the results of control group ($\overline{X}$ = 7.35). Statistically, there is a significant difference between them (P<0.05).That result shows that the concept mapping method is more superior method than the traditional lecture method.

CONCLUSIONS AND SUGGESTIONS

In the study presented above, it can be found out that the findings imply that concept maps are potentially useful tools for learning mathematics more meaningfully and more conceptually. The classroom practices of these tools are worthy of further investigation. As the data demonstrates, constructing concept maps brings a deep understanding of how concepts and recommended strategies are developmentally progressed and built up across the stages while constructing the diagrams enhances the critical synthesis of the relevant mathematical principles. Collectively the impact engenders a better appreciation of how the main concepts and recommended strategies are developmentally progressed within each sub-strand, and how its mathematical principles are applied in methods as demonstrated by the sample data presented.

It's clear that the visual displays of networks of propositions on concept maps and theoretical and procedural information of mathematical on the diagrams effectively encapsulated the interconnection between the knowledge and skills. This suggests the potential educational value of regularly exposing primary students to the strategies of concept mapping to enhance and develop both their conceptual and methodological understanding of mathematics. Doing so would necessarily enable working and communicating mathematically amongst students in the classroom. Having students regularly construct their own maps and diagrams before and after a topic, as part of their normal mathematics classroom practices can lead to a more integrated and interconnected understanding of mathematics concepts and strategies as well as the development of critical thinking and reasoning.

Findings from this case study contributes experimental data to the literature on the use of concept maps as feasible tools that, through their routine construction, can encourage students to engage in the processes of critical analysis and synthesis, organizing, thinking and reasoning, justifying and explaining their knowledge and understanding of a situation publically for social critiques, assessment and evaluation.

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Резюме

Исследование, описанное в этой статье рассмотрены ли понятие отображения могут быть использованы, чтобы помочь студентам улучшить их успеваемости и интересов на булевой алгебре.

Resume

The study described in this article has examined whether concept mapping can be used to help students to improve their learning achievement and interests on Boolean Algebra.

Özet

Bu makalede anlatılan araştırma kavram haritalama öğrenme başarısı ve Boole Cebri üzerinde çıkarlarını geliştirmek için öğrencilere yardım etmek için kullanılabilir olup olmadığını inceledi.