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What is the impact of the teaching "Algebraic Expressions and Equations" topic with concept cartoons on the students' logical thinking abilities?

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Abstract

The purpose of this research is to investigate whether teaching "Algebraic Expressions and Equations" topic with concept cartoons has impact on students' logical thinking abilities. The research is quasi-experimental study and it was conducted with 92 students in the 7th grade in a primary school in Istanbul in 2008-2009 academic years. One experimental group and one control group were used. While the topic "Algebraic Expressions and Equations" was instructed through from textbook in the control group, it was instructed with concept cartoons in the experimental group. The data gathered through "The Logical Thinking Test" used before and after the research were assessed through statistical analysis method. While there is a meaningful difference in the pre- and post-tests of the experimental group and control group supporting post-tests in the end of the study, there is no statistically meaningful difference between the post-tests of the groups.

Keywords: Mathematics education; concept cartoons; algebraic expressions and equations; logical thinking; conceptional learning.

1. Introduction

The concepts in mathematics are interrelated due to their abstract and axiomatic structure. Therefore, the basic concepts must be well-structured and the relation between them must be well-understood. Researches demonstrate that students fail in the processes which especially question conceptual and cause and result relations as they memorize algorithmic structures without signifying mathematical structures.

In learning abstract concepts, students' acquiring the ability of abstract thinking is important. Those people who show such a development can only learn and relate abstract concepts meaningfully. The studies conducted reveal that acquiring the ability of abstract thinking and investigating is an important factor of achievement in science. Thereby, "Logical Thinking Ability Test", developed by Tobin and Capie (1982), which measures people's logical ability, has been conducted as a criterion of scientific achievement. It defines scientific investigation as "Being able to make connections between observable happenings, being able to design an experiment in order to test the

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hypothesis related with the connection, thinking plausible alternatives and outcomes, predicting the outcomes within the chain of logic, being able to evaluate the data and verifying the result giving many examples in this topic."

Cartoons include effective messages which are studied in very details by the help of observations and which are obtained through making these details simpler. Therefore, the informing and thought-provoking function of a cartoon increases the impact of the cartoon in education. With its mild effect on the authoritarian pressure of education, a cartoon is a material that can be more influential in raising qualified individuals. The humor of a cartoon the lovely face of cartoon design will function as medication coated by chocolate for students (Göker, 2007).

Cartoons have been employed in a variety of ways for educational purposes. These include the development of reading skills (Demetrulias 1982) and vocabulary (Goldstein 1986); problem solving (Jones 1987) and thinking skills (De Fren 1988); enhancing motivation (Heintzmann 1989); resolving conflict (Naylor and McMurdo 1990); eliciting tacit scientific knowledge (Guttierrez and Ogborn 1992) and making scientific ideas accessible (Peacock 1995).

On the other hand, concept cartoons are interest-arousing and surprising drawings in the form of a cartoon in which each cartoon character defends different viewpoints concerning a happening in daily life (Keogh & Naylor, 1999a; Martinez, 2004). Concept cartoons show different specialties from ordinary cartoons. While cartoons are used to make people laugh, concept cartoons are used to entertain students and make them inquire their knowledge (Keogh & Naylor, 1996b).

According to Naylor and Keogh (2000) can be used the concept cartoon in education that is the student's ideas outward; regulation ideas and systematic ; students gain an alternative perspective; in creating of discussion environment. Dabell (2004) indicate concept cartoons help the students to question their thoughts, solve the problem they encounter in their everyday lives, broaden their horizons and provide different perspectives for the events.

2. Method

In this research, quasi-experimental design with pre-test post-test control group was used. In pre-test post-test control group quasi-experimental design model, along with experimental group exposed to independent variable, there is additional group not exposed to independent variable. This design includes one experimental group and one control group and participants are not determined arbitrarily. If there is no significant difference between the pre-test scores of the group, the relative equality of the groups can be talked about. In order to test the groups, the scores of the two groups varying from the pre-test to the post-test are compared to specify whether there is a meaningful difference (Bulduk, 2003). The research was conducted on total 92 seventh-graders in two different classes in a primary school in Istanbul in 2008-2009 academic years. In order to determine the experimental group and control group, two classes close according to pre-logical thinking scale scores were selected. In the experimental group there are 46 and in the control group there are 46 students.

2.1. Instruments

The data of this research were obtained using "Logical Thinking Ability Test."

Logical Thinking Ability Test (LTAT): Logical Thinking Ability Test (LTAT) used in order to determine prospective teachers' logical thinking ability was developed by Tobin and Copie (1981). The Turkish translation and adaptation of the test was conducted by Geban, Aşkar and Özkan (1992) and the Cronbach Alpha reliability coefficient of the test was found as 0.77. The test comprises of 10 two-stage questions measuring five logical operations: proportional thinking (2 questions), checking the variables (2 questions), and thinking with probability (2 questions), relational thinking (2 questions) and combined thinking (2 questions). For this research, the reliability of the test was found as α=0.81.

2.2. The Gathering and Analysis of the Data

Before beginning the research, the "algebraic expressions and equations" subfield of Algebra learning field in the new mathematics program was treated. Taking the sufferings of the students in the sixth-grade about algebra, the acquisitions of 6^{th} and 7^{th} grade algebraic expressions learning subfield and equations learning subfield were unified. Afterwards, different stories concerning each acquisition were written and relevant concept cartoons were drawn,

and these concept cartoons were shaped as activity sheets through the use of computer programs. Experts were consulted about whether the cartoons were suitable for the students pedagogically and whether they were compatible with the acquisitions in conceptual dimension. While the concept cartoons were being drawn in accordance with acquisitions, whether they expressed each acquisition clearly were treated. In each concept cartoon activity, different stories and characters relevant with the stories were used. The characters were placed into the everyday situations students met. Additionally, several problems in the textbook were concept cartooned. Having a general problematic situation presented, concept cartoons were given and the dialogs between characters were placed into interesting boxes. Having free spaces on the sheets for the students to study eliminated the need to write on the notebook.

Following the preliminary preparation, "Logical Thinking Ability Test" was implemented in four seventh grade classes. Having specified two classes therein there is no difference statistically meaningful in terms logical thinking ability, one class was selected as control group and the other was selected as experimental group. While in the control group the lessons were being covered through from texbook, in the experimental group they were covered through concept cartoons. During the research, activity sheets were projected through projector in the classroom and the sheets were color copied and handed to the students. Moreover, the students in the experimental group were homogeneously grouped and they were let discuss with each other and negotiate. Having handed the activity sheets to the groups, the students were given time to answer a problem case which is the main theme in each sheet. A different group was determined for each activity sheet and the dialogs were shared in the classroom. Later, the answers were obtained from the groups one by one. In this situation, different answers supplied the opportunity to discuss between the groups. Having answered the questions in the last section, another activity sheet was treated. Following a four-week research, the experimental group and control group were implemented "Logical Thinking Ability Test" again.

2.3. The solution and Interpretation of the Data

For the research duration, statistical analysis method was used for the analysis of the obtained data. In order to determine whether the obtained data was suitable for the normal distribution Double Sample Kolmogorov-Smirnov test was implemented. In the analysis of Pre-Logical Thinking-Post-Logical Thinking Ability Scales, the scores of the students in the same group were compared through Paired Sample T-Test and the scores of the students in different groups were compared through Independent Sample T-Test. The meaningfulness levels of the data obtained in the research were evaluated considering $p<.05$.

3. Results

Looking at the results belonging to Double Sample Kolmogorov-Smirnov test, the p values of pre-Logical Thinking Ability scale of the control group and experimental group is found to be 0.995. The p values of post-Logical Thinking Ability scale of the control group and experimental group is found to be 0.949. Considering the results, p values are bigger than 0.5. In this situation, the obtained values are found to be compatible with the normal distribution and it was decided that the use of t test was suitable. Determining the data are compatible with the normal distribution, the following results were obtained:

Table 1: The T-Test Results Concerning the Scores of Pre-Logical Thinking Ability Scale of the Students of Experimental and Control Group

Groups	N	$\overline{X}$	S	sd	t	p
Experiment	46	2.26	1.97	90	.362	.718
Control	46	2.13	1.43			

Considering the results of the Pre-Logical Thinking Ability scale, it is seen that the average of the scores of the students of the experimental group is 2, 26; the average of the scores of the control group is 2, 13. In order to determine whether there is a meaningful difference between the scores of Pre-Logical Thinking Ability scale scores of the experimental group and control group, T-Test for Independent Samples was implemented and p was found to be p=0, 718. As the p value found was bigger than 0.5, it was decided that there was no meaningful difference between experimental group and control group.

Table 2: The T-Test Results Concerning the Post-Logical Thinking Ability Scale Scores of the Students of the Experimental Group and Control Group

Groups	N	$\overline{X}$	S	sd	t	p
Experiment	46	4.58	3.04	90	.861	.392
Control	46	4. 04	3. 01			

Considering the scores of the Post-Logical Ability scale, it was found that the average of the students of the experimental group was 4.58 and the average of the control group students was 4.04. In order to specify whether there is a meaningful difference between the scores of the Post-Logical Thinking Ability scale of the students of the experimental group and control group, T-Test for Independent Samples was implemented. The p value obtained is 0. 392. The fact that the p value found was bigger than 0.5 demonstrates that there is no meaningful difference between the two group following the implication. However, considering the averages of the two groups, it is seen that the rise in the averages of the control group where the topic algebraic expressions and equations was covered through concept cartoons is higher.

While the averages of the pre-Logical Thinking Ability scale scores of the students of the control group were being calculated as 2.13, the average of the post-Logical Thinking Ability scores was found 4.04. The T-Test for Dependent Samples was implemented to the scores of this scale and p value was determined as 0.00. Since the p value found is smaller than 0.5, it is seen that there is a meaningful difference between the scores of the pre- and post-Logical Ability of the students of the control group. Considering the averages, the interpretation the teaching of the topic algebraic expressions and equations through from textbook increases the Logical Thinking Abilities of the control group is possible. The average of the pre-Logical Thinking Ability of the experimental group is 2.26 and the average of the post-Logical Ability is 4.58. T- Test for Dependent Samples was implemented to the scores of the pre- and post-Logical Thinking Ability scales and p value was found 0.00. Since the p value found is smaller than 0. 5, it is concluded that there is a meaningful difference between the pre-Logical Ability and post-Logical Ability scale scores of the experimental group students. Considering the averages, it can be interpreted that covering the topic algebraic expressions and equations through concept cartoons affects experimental group students positively and increases their Logical Thinking Abilities.

4. Discussion and Suggestions

The purpose of instructing through concept cartoons is neither entertaining nor making students memorize but it is thought-provoking teaching and develops creativity (Örs, 2007). Cartoons can be benefited through a variety of different purposes such as making students acquire thinking skills, making them have scientific concepts and increasing their motivation. Taking the findings of this study into consideration, though teaching through concept cartoons does cause a statistically meaningful change on the logical thinking abilities of students compared with the the course textbook processing , it is found to be more influential when arithmetical averages are compared. It is thought that the study's being limited with four weeks and moreover this is students' first encounter with concept cartoons, therefore it is a novel instructing method are also effective in attaining this result. Our thought is also supported by the finding in the studies conducted by İnel, Balım & Erekli (2009), "While students 70 % mention that they encounter concept cartoons for the first time, they 30 % mention that they have encountered concept cartoons in test and question booklets."

In the light of mentioned results, it is thought that placing students into longer inquiry and discussion environment will help them structure knowledge, and using unwritten concept cartoons in order them to perceive this process in higher dimension, and their creating their own concept cartoons in different mathematical topics through group work will be influential in creating a student profile whose logical thinking skills are developed and who are research and inquiry-based.

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