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Effects of Concept Cartoons on Mathematics Self-Efficacy of 7th Grade Students

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Abstract

The purpose of this research is to determine the effect of concept cartoons on the students' perception of their levels of self-efficacy towards mathematics. The research has been designed as the pre-test post-test with quasi experimental control group. The research participants are composed of 94 7th grade students attending an elementary school on the European side of Istanbul during the 2008-2009 Academic Year. "Algebraic expressions and Equations" were taught during four weeks by using sixteen concept cartoons which were developed in this study. Homogenous groups, each consisting of four students sharing the same opinions, were utilized in order to enable them to discuss the concepts more comprehensively and to question their own thinking patterns by creating a social learning environment. The data of the research was collected by "Mathematical Self Efficacy Levels Perception Scale" and through the written opinions of the students about implementation process. While the quantitative data was analyzed by performing the t-test for dependent and independent samples, the qualitative data was descriptively analyzed. The results of the research have shown that concept cartoons have a significant effect on the students' perception of their level of mathematical self-efficacy. Besides, it was found out that students liked concept cartoons very much, their interest to the lesson was increased and they believed they could do mathematics lesson. In the light of the findings of this study, the researchers have developed suggestions for those who will conduct further researches on concept cartoons.

Key Words

Mathematics Teaching, Perception of Mathematical Self-Efficacy, Concept Cartoons, Algebraic Expressions and Expressions.

Self-efficacy, one of the key concepts of the Social Cognitive Theory, is defined as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1997). Self-efficacy is related with the beliefs on what individuals can do with their skills but not related with their observed skills. That is, it is the self-confidence of individuals and by the time it is a belief developed through experiences (Gawith, 1995; Lee, 2005). Recently, the interest for the concept of self-efficacy has continually increased as long as social cognitive theory has developed in recent years (Murdock & Neafsey, 1995).

Woolfolk (1993) who is one of those who study on self-efficacy defines self-efficacy as "the ability of a person to organize his / her skills and his / he beliefs that s/he can develop efficiency in a newly acquainted situation; Hacket and Betz (1989) defines self-efficacy as "an important cognitive determiner of individuals whether they will attempt a behavior and Zimmerman (1995) defines it as "the judgments of an individual about his/her ability to perform, succeed in an action".

Hackett and Betz (1989) define the mathematics self-efficacy as "an individual's confidence in her or

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his ability to successfully perform or accomplish a mathematics task". Many researchers have studied the relations between mathematics self-efficacy and a number of variables (mathematics achievement, mathematics attitude, mathematics anxiety, and interest in courses related to mathematics, and choosing a profession related to mathematics) in many studies conducted in this field.

A significant relation was found between students' mathematics achievement and their self-efficacy in many studies addressing the mathematics self-efficacy (Bouffard-Bouchard, 1990; Chen, 2002; Hacket & Betz, 1989; Kloosterman, 1991; Lent, Lopez, & Bieschke, 1993; Matsui, Matsui, & Ohnishi, 1990; Migray, 2002; Moore, 2005; Pajares, 2002; Zimmerman, 2000; Zimmerman & Ringle, 1981). Likewise, it was found that mathematics self-efficacy is a significant variable between mathematics attitude and mathematics achievement (Betz & Hacket, 1983; Hackett, 1985; Hacket & Betz, 1989; Randhawa, Beamer & Lundberg, 1993).

The source of the effort students will show when they start a certain learning process comprises of interest, manner and the belief of achievement which are the components of affective domain. According to Bloom (1998), the components of affective domain explain 25 % of the change in learning products; that is, one fourths of the differences between the learning performances of individuals stem from affective features. Moreover, the belief of self-efficacy is an important determiner of the achievement of persons in mathematics (Kiemanesh, Hejazi, & Esfahani, 2004). According to Zimmerman, Bandura and Matinez-Ponds (1992), self-efficacy and use of strategy explain 30 % of the variability in academic achievement.

Studies conducted show that it is important that students can develop a positive mathematics self-efficacy perception. This shows that students need an inquiry-based social learning environment, which will enable them to participate in learning processes that will allow them to experience the feeling of confidence and achievement, where they can develop their own cognitive restructuring by discussing the concepts they are to learn. Since students need to be active in the restructuring process according to the constructivist approach, it is important to use visual tools that would involve students in the lessons, and enable them to learn more meaningfully by creating a discussion environment. One of these tools is the concept cartoons (Balım, İnel, & Evrekli, 2008).

Concept Cartoons

Concept cartoons were first designed and used in science classes by Naylor and McMurdo (1990). Researchers defined the concept cartoons as "depiction of dialogues in which 3 or more students are involved". Each of the characters in the concept cartoons has different perspectives and statements. One of the statements in these cartoons represents the one that is accepted scientifically to be true; on the other hand, the rest are accepted to be not true – while the students may think otherwise (Naylor & McMurdo, 1990).

Ideas attributed to the characters in concept cartoons are given in dialogue boxes. Thus, opinions are justified in an environment of discussion among the characters in the cartoon. Consequently, teachers are able to guide students by involving them in the discussion among the characters in concept cartoons (Kabapınar, 2005; Keogh, Naylor, & Wilson, 1998).

Studies conducted in Turkey and the world have shown that cartoons and concept cartoons increase motivation towards lessons (Greenwald & Nestler; 2004; Keogh et al., 1998; Rule & Auge, 2005; Üstün, 2007); facilitate learning and interpretation of knowledge (Keogh et al., 1998, Keogh, Naylor, De Boo, & Feasey, 2001; Özalp, 2006; Stephenson & Warwick; 2002); increase achievement (Durualp, 2006; Rule & Auge, 2005); help students to critically evaluate the information they newly encounter using their existing knowledge, and consequently affect their associated perceptions (Balım et al., 2008; Ersoy & Türkan, 2010; Naylor, Downing, & Keogh, 2001); decrease students' mathematics anxiety (Greenwald & Nestler, 2004); develop a positive attitude towards textbooks (Özalp, 2006); reveal the reasons underlying misconceptions, encourage students to research, and eliminate misconceptions (Çiğdemtekin, 2007; Kabapınar, 2005), and that they can be used as a potentially invaluable evaluation method in teacher training (Keogh et al., 2001).

Purpose

The purpose of this study is to investigate the effects of concept cartoons on mathematics self-efficacy perception levels of 7th grade students.

Method

Model

A quasi-experimental design with pre-test/post-test control group was used in this study. This model consists of an experimental group affected by the independent variable, as well as an additional group that is not affected by the same. Hypotheses are tested by comparing scores of both groups varying from pre-test to post-test in order to determine whether there are any significant differences (Bulduk, 2003; Christensen, 2004; Yıldırım & Şimşek, 2005).

Study Group

The study was conducted on total of 94 seventh grade students studying at two different departments of a primary school located in Istanbul province in the 2008-2009 school years. There were 46 students in the experimental group and 48 students in the control group. 25 (54.3%) students were female and 21 (45.7%) students were male in the experimental group; and 26 (54.2%) students were female and 22 (45.8%) students were male in the control group. The mathematics achievement of students in the experimental and control groups was at mediocre level and levels were similar. Five students, who were most suitable for the purpose of the study and it was determined to represent the opinions of the experimental group, were selected from among the experimental group using purposeful sampling method in order to collect qualitative data. The researcher includes those that are the most suitable for the purpose of the study in the sample in purposeful sampling method (Balcı, 2005).

Data Collection Tools

Data collection tools are handled in two categories: qualitative and quantitative. The "Matematiğe Karşı Öz-yeterlik Algısı Ölçeği" [MKÖAÖ] developed by Umay (2001) was used for measuring the mathematics self-efficacy perceptions of students in collection of the quantitative data for the study. The Likert-type scale contains total of 14 items: 8 positive (1, 2, 4, 5, 8, 9, 13, 14) and 6 negative (3, 6, 7, 10, 11, 12) items. It is designed as a 5-point Likert scale with response categories of: Never (1), Rarely (2), Sometimes (3), Usually (4), Always (5). The scale is composed of three sub-dimensions: mathematics self-perception, awareness of their attitudes in mathematics subjects, and ability to convert mathematics to life skills. The researcher calculated the reliability coefficient of the scale as .88. The Cronbach alpha coefficient of the scale for this study was .70.

Document review method, one of the qualitative research techniques, was used to obtain qualitative data. The personal documents used in this study consisted of the written materials containing the answers to the open-ended question "What are your opinions about teaching via concept cartoons? Please explain."

Procedures

As the issue of research, "Algebraic Expressions and Equations" issue is selected. In the selection of this issue, two situations are taken into consideration. Firstly, according to new mathematics program which has been gradually put into use in Turkey since 2005, students have been aimed at acquiring algebraic operations skills, noticing equations and systems of equations and acquiring the skill of accomplishing them in daily life problems (Milli Eğitim Bakanlığı [MEB], 2006). According to National Council of Teachers of Mathematics (NCTM) (2000), students have to understand the concepts concerning algebra, the construct and principles which underlie symbolic operations and notice how to use the symbols. Secondly, the researches conducted provide findings that students have difficulties in this issue. While, according to MacGregor and Stacey (1997) who are from these researchers, students have problems in "turning verbal expressions into algebraic expressions" and in "setting the equation compatible with verbal expressions", Booth and Herscovics (1986) mention that in addition to "students cannot signify algebraic expressions, and they do not have algebraic logic, most of them do not have any idea in what algebra is and what the purposes of algebra are."

Total of 16 concept cartoons were created by the researcher and three mathematics education specialists, by evaluating the same in terms of the contents and suitability to the level of students. Concordance among the evaluations of the researcher and the three specialists was calculated by the following formula indicated by Miles and Huberman (1994): Concordance Percentage = [Agreements / (Agreements + Disagreements)] x100. Concordance percentage was calculated 91 as a result of this calculation.

Classes were taught by teacher-centred activities in the control group, while concept cartoons were used in the experimental group. The concept cartoons were prepared in the form of worksheets and projected on a screen using an overhead projector, and they were also handed out to students as colour printouts. Four-person homogeneous groups were constructed to enable the students to create a social learning environment and discuss the concepts more comprehensively (Hiebert & Carpenter, 1992).

Prior to commencement of the application, students were informed of the concept cartoons as a teaching method, and the cartoons to be used were introduced. Then, after handing out the activity sheets containing the concept cartoons to the groups, students were given time to provide their answers following introduction of the problem status forming the main theme of each sheet. A different group was determined for each activity sheet, and dialogues were shared with the classroom. In this case, existence of distinctive answers enabled discussions among groups. Following the discussion session, the teacher asked questions such as "What happened? How did you understand? What is the result? Why is it so? Then, what should it be? Which character's opinion turned out to be true? Where did we go wrong?", etc. in order to enable the students to question themselves with respect to the character whose opinion proved to be true, and the reasons of discord (Wertsch, 1991).

The "Mathematics Self-Efficacy Perception Scale" was re-applied to the experimental and control groups after 4-week research following completion of the questioning process. Furthermore, students' written opinions were obtained using the question "What are your opinions about teaching via concept cartoons?" in order to enable them to evaluate the application process.

Analysis of Data

The scores obtained by students from the "Mathematics Self-Efficacy Perception Scale" pre-test/post-test were evaluated using the SPSS software package on computer environment. The "independent group t-test" was used in paired comparisons between different groups, and "dependent group t-test" in paired comparisons within groups themselves depending on the types of data. Differences between the experimental and control groups were found to have a significance level of $p<.05$ according to the relevant variables. Opinions of students about the lessons taught via concept cartoons were subjected to a descriptive analysis.

Results

This section provides the findings obtained from the "Mathematics Self-Efficacy Perception Scale" pre-test/post-test administered to students in the experimental and control groups. However, Kolmogorov-Smimov tests were conducted to establish whether the results had normal distribution prior to analysis of the tests. According to this test, if the $p> .05$, then the data has normal distribution and they can be analyzed with the t-test. Accordingly, results of the Kolmogorov-Smimov test conducted on the results of the mathematics self-efficacy perception scale pre-test administered to the experimental and control groups are as follows respectively: (KSZ=.990, p=.281>.05) and (KSZ=.624, p=.830>.05); and the results of the Kolmogorov-Smimov test conducted on the results of the post-test are as follows respectively: (KSZ=.615, p=.844>.05) and (KSZ=.602, p=.862>.05). Because it was seen that the tests had normal distribution on the basis of these results, it was decided to use the t-test in other analyses.

Results of the independent group t-test conducted on the mathematics self-efficacy perception scale pre-test scores of the experimental and control groups showed no significant difference at a statistical level of significance of 0.05 in terms of the mathematics self-efficacy perceptions between the two groups [t(92)= -.346, p>.05]. Furthermore, the result of the Levene's Test applied to the mathematics self-efficacy perception scale pre-test data of the experimental and control groups was (F =1.733 p=.191), and therefore it can be said that the group variances were homogeneous at the p>.05 significance level, i.e. groups had equal variances. Consequently, it can be said that the mathematics self-efficacy perceptions of students in the control and experimental groups were equal prior to application.

Results of the dependent group t-test conducted on the mathematics self-efficacy perception scale pre-test and post-test scores of the experimental group showed significant difference at a statistical level of significance of 0.05. [t(45)= -7.566, p<.05]. Consequently, it can be said that the concept cartoons have a positive effect on students' mathematics self-efficacy perceptions.

Results of the dependent group t-test conducted on the mathematics self-efficacy perception scale pre-test and post-test scores of the control group showed no significant difference at a statistical level of significance of 0.05 [t(47)= -1.396, p>.05]. Consequently, it can be said that there was no change in the mathematics self-efficacy perceptions of students in the control group.

Results of the independent group t-test conducted on the mathematics self-efficacy perception scale post-test scores of the experimental and control groups showed a significant difference at a statistical level of significance of 0.05 in terms of the mathematics self-efficacy perceptions between the two groups [t(92)= 3.67, p<.05]. This difference is in favour of the experimental group. Consequently, it can be said that the concept cartoons increase students' motivation towards learning, and facilitate learning and interpretation of knowledge.

Students' opinions obtained following completion of the application indicate that they enjoyed the mathematics lesson taught using concept cartoons, they were more attentive to the lesson, they became aware of many things that they had been unable to understand and then started to understand, they began to understand the mathematics in general, and that they were even unwilling to leave the class. Consequently, it can be said that students' affective characteristics, such as "I can achieve" and "I can be successful", are positively affected as a result of increase in their attention to the lesson.

Conclusion and Discussion

This study investigates the effects of the concept cartoons on mathematics self-efficacy of 7th grade students. *A statistically significant difference is found between the average scores of the mathematics self-efficacy perception scale pre-test/post-test of the experimental group students, who were taught using concept cartoons.* This finding shows that concept cartoons lead to a significant increase in students' mathematics self-efficacy perceptions. This finding of the study support the previous studies conducted by Çiğdemtekin (2007), Greenwald and Nestler (2004), Keogh et al., (1998), Long and Marson, (2003), and Özalp (2006) that concept cartoons enhance motivation of students by facilitating concentration on the subject being taught. In his study titled "Prospective Teachers' Opinions about Concept Cartoons Integrated with Modular Instructional Design", Cengizhan (2011) states that concept cartoons are the teaching activities and visuals that draw the most attention among the modules, that they enhance motivation and render the lessons more interesting. Evaluating the concept cartoons in terms of teaching, Keogh and Naylor (1999) requested the teachers that participated in their study to evaluate the teaching based on concept cartoons. According to the results of their study, teachers stated that the concept cartoons significantly enhanced motivation even in students suffering learning difficulties, that they created classroom discussions with broad participation, and that they drove students to conduct researches to validate the arguments presented in cartoons. The results of this study and opinions of students relating to the lessons taught via concept cartoons support the findings of the aforementioned study.

According to Piaget (1973), basis of learning is exploration or restructuring through exploration. It is believed that use of concept cartoons in learning environment supports students' natural curiosity by creating the opportunity to explore and to restructure the concepts correctly. As expressed by students, e.g. "*As we discuss, I become aware of the fact that there are many points I cannot understand*", and "*When we discuss the subjects, I immediately become aware of the points that I cannot understand, and they quickly get settled*", regarding the application process, it can be said that the social learning environment created by way of concept cartoons enable students to structure the information meaningfully by enhancing their awareness (Akar &Yıldırım, 2004; Vygosky, 1962).This finding of the study matches the finding obtained in studies conducted by Ekici, Ekici and Aydın (2007), Kabapınar (2005), and Rule and Auge (2005) that concept cartoons eliminate misconceptions and are an effective teaching tool. On the other hand, students in a classroom environment where concept cartoons are used have the opportunity to evaluate themselves and their peers while expanding their knowledge. For example, students' opinions such as "*I was always asking myself why I cannot understand maths. I was unable to give an answer most of the time, for it should have been so. Now, I have started to understand its reasons thanks to the cartoons*", "*Now, we question everything by the help of cartoons. We discuss everything*", and "*All my schoolmates and I try to answer the questions*" match the finding obtained in studies conducted by Cengizhan (2011), Akdeniz and Atasoy (2006), Özalp (2006), Keogh and Naylor (1999), and Morris, Merritt, Fairclough, Birrell, and Howitt (2007) that concept cartoons encourage students to

research by creating a discussion environment in the classroom.

No statistically significant differences were found among the mathematics self-efficacy perception scale pre-test/post-test score averages of the students in the control group. It is believed that the reason of this situation was that a very limited number of activities were used in lessons taught in the control group, and that it was the result of the teacher-centred activities. Teachers could only use the board to present the activities and try to teach the subjects by solving problems. Even though teachers tried to teach subjects by asking questions to students, participation of students in the lesson and creation of a discussion environment was not on a desired level. Receipt of knowledge with a passive receptive role, and lack of opportunity to restructure the concepts as required, leads to a decrease in students' interest towards lessons, when we take into consideration the difficulty of subjects being taught as well.

A statistically significant difference was found among the mathematics self-efficacy perception scale post-test score averages of the experimental and control groups. This difference is in favour of the experimental group, in which lessons were taught via concept cartoons. This finding of this study matches the finding obtained in studies conducted by Richardson (1997), Risemberg and Zimmerman (1992), and Valsiner (1991) that students that participate in the learning process effectively learn the subjects more easily, become more successful, and have high self-efficacy levels. Taking into consideration the fact that students with high self-efficacy put more effort to register greater achievement, it can be said that, concept cartoons would make positive contributions to their achievement in mathematics classes. Students' opinions such as "*If all our lessons had been taught in this way, I would have been more successful in mathematics now. But, I believe that I will now be able to be more successful in maths, if cartoons are used during the lessons,*" and "*I want to study maths every day at school. I have seen that I would be more successful in maths, if subjects were taught using cartoons*" can be accepted as an indication of this fact. This finding of this study also matches the finding obtained in studies conducted by Hackett and Betz (1989), Hafner (2008), Matsui et al., (1990), Pietsch, Walker and Chapman (2003), Pajares and Miller (1994), Pajares and Kranzler (1995), Randhawa et al., (1993), Shih and Alexander (2000), Schunk (1981), and Wolters and Pintrich (1998) that students with high-efficacy have higher achievement levels in mathematics.

According to Chin and Teou (2009), students are able to express their opinions more comfortably and become aware of their own skills in a social learning environment created using concept cartoons. Furthermore, teachers find the opportunity to provide immediate feedbacks when they notice any thought patterns that would lead to misconstruction of already existing or new concepts in students as they comment on ideas by way of concept cartoons. Thus, students develop self-confidence and are able to learn abstract mathematical concepts more easily by concretizing them. Students' opinions such as "*Our teacher always asks us questions using cartoons*", "*Maths has become more logical, I didn't think this way before,*" and "*I become aware of that I cannot understand many points as we discuss the subjects*" support these opinions.

As also emphasized by students in their written opinions, it was observed that they very much liked the concept cartoons, they did not even want to leave the class, and that their attention to lessons increased. Based on the opinions such as "*I can understand the maths, and I started to like it*", "*My interest in maths gradually increases. If my interest in maths was 35% before use of cartoons, it has become 95% now. Lessons are very much enjoyable now*", and "*Everyone who understands the subjects, start loving the maths*" expressed by students, who were not successful in mathematics previously and started to understand the maths subjects, it can be said that, use of concept cartoons in teaching positively affects students' cognitive characteristics and their attitude towards mathematics. This result of the study matches the finding obtained in studies conducted by Dereli (2008) and Üner (2009) that use of concept cartoons in teaching affect students' attitude towards mathematics positively. Additionally, this finding also matches the finding obtained in studies conducted by Çiğdemtekin (2007), Durmaz (2007), Keogh and Naylor (1999), and Keogh et al. (1998) that use of concept cartoons would be important in teaching abstract disciplines such as mathematics and in development of affective characteristics of students.

Based on the findings obtained, it can be said that:

- Teachers may make use of concept cartoons to draw students' attention to the lesson, and to ensure their active participation;

- Taking into consideration the results of the studies indicating that concept cartoons positively affect the mathematics self-efficacy, and that students with high self-efficacy have higher mathematics achievement, it would be advantageous if teachers used concept cartoons to increase students' mathematics achievement and their attitude towards mathematics;

- Hacket and Betz (1989) assert that, according to the social cognitive theory, low mathematics self-efficacy is the source of mathematics anxiety. According to the results of this study, it can be said that concept cartoons can be an effective tool in elimination of mathematics anxiety.

Furthermore, it is suggested that it would be worthwhile to study whether the concept cartoons have a significant effect on logical thinking and critical thinking skills of students, and to study their effects on problem solving and metacognitive skills of students.

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