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Impact of instruction with concept cartoons on students' academic achievement in science lessons

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In this study, the impact of concept cartoons on students' academic achievement in science lessons was investigated. The research was carried out in 2018-2019 spring term. The study group consisted of 49 4th grade students in Zonguldak Devrek Çaydeğirmeni TOKİ Primary School. 23 of the students were in the experimental group, and 26 of them were in the control group. Quasi-experimental design with pretest and posttest control group was employed in the study. The unit "The Earth Crust and Movements of The Earth" was taught with concept cartoons to the experimental group students, and with conventional method (current instructional program) to the control group students. The research lasted for 4 weeks. The students in the experimental and control groups received 12 h of education (3 h per week). Achievement test and concept cartoons were used as data collection tools. Arithmetic mean, standard deviation, normality test, KMO test and independent groups t-test were used for data analysis. A statistically significant difference was found between academic achievements of experimental group students on whom instruction was made with concept cartoons and of control group students on whom instruction was carried out with conventional method. The difference was in favor of the experimental group students.

Key words: Science, concept cartoons, conventional method, academic achievement, experimental group, control group.

INTRODUCTION

The studies in the area of education and training have always tried to find answer to this question: How can people learn better and more easily? While searching answer to this question, new instructional theories, approaches, methods and techniques were obtained. Scientific knowledge obtained in the area of education is a result of these studies. However, information about how people can learn better has not been found yet. Final changes in curriculum have promoted students to be active in education. Reaching knowledge and constructing it in mind have been missions of students whereas teachers have taken the role of guiding students.

Constructivist approach was adopted while making changes on Science curriculum in Turkey (MEB, 2005). According to constructivist approach, learning is shaped with regard to individual's prior knowledge, his/her personal characteristics and learning environment (Özmen, 2004). Constructivist approach argues that

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learning happens as a result of an active learning process which is constructed by an individual through interpersonal variations and by interaction with physical phenomena (Watts, 1997; Spigner-Littles and Anderson, 1999). Constructivist approach suggests that learning is a process that includes association of prior and new knowledge of an individual (Liang and Gabel, 2005). Activities in which students are required to be active have gained importance with the changes in the curriculum (Gürol, 2003). In this context, learning environment in which students are included and instructional methods and techniques are pretty important in increasing quality (Hançer et al., 2003).

Although a constructivist approach has been adopted in the science curriculum, the lessons are still taught using traditional methods.This situation adversely affects the students' active participation in the lesson.However, the constructivist approach requires methods and techniques that ensure the active participation of the students in the lesson and supports individual differences. From this perspective methods and techniques are needed ın the Science lesson to ensure the active participation of the students in lesson. Teaching methods and techniques used in teaching process have great importance in students' active participation in classes, in focusing their attention to classes, in their producing original ideas, in their improving creativity skills, in their assessing course contents, briefly, in enabling permanent learning. In this regard, it can be suggested that instruction with concept cartoons is effective in teaching process. Concept is a general name of an object or thought in mind. Concept refers to the word based on information obtained about an object or a topic. Learning concepts accurately facilitate reaching information about concepts; however, learning them inaccurately may cause misconceptions.

Misconceptions are information that hinder teaching concepts that happen as a result of individual experiences and that are scientifically verified (Çakır and Yürük, 1999). Another description identifies them as behaviors that occur in consequence of students' false beliefs and experiences (Baki, 1999). Students' learning concepts about content of science lessons is important in terms of course learning outcomes. A concept which is learnt inaccurately or incompletely can lead to misconceptions.

True learning becomes quite difficult after mislearning. Therefore, while teachers teach a new concept, they should arrange teaching process efficiently (Yürümezoğlu et al., 2009). When misconceptions are analyzed, it can be seen that meanings of these concepts are pretty different from their real meanings. These mislearned concepts affect students' true learning negatively and decrease their academic achievement (Driver and Easley, 1978; as cited by Yağbasan and Gülçiçek, 2003). Students' active participation in classes is crucial in terms of true and sustainable learning.

Learning approaches that enable students' active participation in science teaching should be used (Köseoğlu and Kavak, 2001). Instruction aided with concept cartoons improves students' active participation in the teaching process. Concept cartoons were developed by Brenda Keogh and Stuart Naylor in 1992. They were created to meet in-service teachers' needs of finding new instructional methods in science education (Van der Mark, 2011). Concept cartoons are visual tools which tell a scientific event with cartoons and give different points of view (Coll, 2005; Stephenson and Warwick, 2002; Naylor et al., 2001; Keogh and Naylor, 2000). Concept cartoons are drawings which consist of written texts in visual or oral forms and express daily life events in cartoon-shape (Keogh et al., 1998; Keogh and Naylor, 1999). Each concept cartoon shows a group of children in a speech bubble based on daily life and children express different opinions on a topic. The alternatives shown in speech bubbles are based on real events, classroom scenarios, common thoughts or misconceptions (Samkova and Hospesova, 2016). Concept cartoons are really effective on visualization of topics, active participation of students and justification of ideas (Morris et al., 2007). Concept cartoons encourage students to search and help them see scientific truths while searching (Kabapınar, 2009; Keogh and Naylor, 2000). Different ways of thinking with concept cartoons are conveyed to students through visual tools; misconceptions of students who have similar ideas are revealed, and reasons of these misconceptions are discussed in the classroom. The fact that concept cartoons include visual elements related to the subject to be taught raises students' attention in the subject and provides students' learning with fun (Balım et al., 2008). Concept cartoon teaching strategy has the potential to increase creativity and innovation as well as students' interest in understanding concepts. It is considered as a method that encourages students to continue exploring issues raised and seeking solutions (Jamal et al., 2019). Concept cartoons have a positive effect on students' critical thinking skills (Demirci and Özyurek, 2017; Yin and Fitzgerald, 2017). Concept cartoons are suggested as teaching materials to be used in science education with respect to the fact that they create learning environment suitable for constructivist approach and overcome problems to be experienced in teaching process (Keogh and Naylor, 1997; Keogh et al., 1998; Naylor and McMudro, 1990). Using concept cartoons in classroom settings help students discuss their opinions in classrooms, question their knowledge and make arrangements in their cognitive structures (Evrekli, 2010). Concept cartoons can be used for improving conceptual understandings of the students and for revealing their misconceptions (Stephenson and Warwick, 2002). Concept cartoons arouse curiosity in young students and develop their investigation and questioning skills (Long and Marson, 2003). Additionally, concept cartoons are assistant tools used in attracting students' attention to

classes and improving their interest in them (Roesky and Kennepohl, 2008). The cartoon concept has succeeded in showing its importance in modern teaching and learning strategies (Koutnikova, 2017). Hence, impact of concept cartoons on academic achievement of primary school 4th grade students in the unit "The Earth Crust and Movements of The Earth" in science lesson was investigated.

Aim of the research

Aim of the research was to analyze effects of instruction with concept cartoons on students' academic achievement in the unit of "The Earth Crust and Movements of The Earth" in primary school 4th grade science lesson. Answers for the following questions were searched to achieve this aim:

1. Are there any significant differences between pretest scores of the experimental group students on whom instruction was carried out with concept cartoons and of the control group students on whom instruction was made with conventional method (instruction based on current curriculum) in the unit of "The Earth Crust and Movements of The Earth" in primary school 4th grade science lesson?
2. Are there any significant differences between posttest scores of the experimental group students and of the control group students in the unit of "The Earth Crust and Movements of The Earth" in primary school 4th grade science lesson?

MATERIALS AND METHODS

Model of the research

Quasi-experimental design with pretest and posttest control group was employed in the study. This design provides great statistical potential to the researcher about testing the effect of intervention on dependent variable, and helps interpretation of findings obtained within the context of cause and effect (Büyüköztürk, 2011).

Study group

The study group of the research was created via convenient sampling in line with the aim of the study. Convenient sampling is described as a suitable method to fasten and ease research when there are problems related to time and expense, and it is a sampling method in which people close and convenient to the researcher are selected (Yıldırım and Şimşek, 2003).

The study group consisted of 4th grade students studying at Zonguldak Devrek Çaydeğirmeni TOKİ Primary School in the second semester of 2018-2019 academic year. 49 students, 23 of whom were appointed to the experimental group and 26 of whom were appointed to the control group, were included in the study.

Process

Data collection tools

Achievement test and concept cartoons were used as data collection tools in the research. These data collection instruments were developed by the researcher. Information regarding development of these tools is listed by titles below.

Development of test questions

The test developed by the researcher consisted of 33 items about a unit in science lesson which was "The Earth Crust and Movements of The Earth". Subject area experts were consulted in confirming items' suitability to the students' levels, their being clear - understandable and their content validity.

This test which included 33 items was applied as a pilot study on 100 4th grade students in a different school from the school where the research was conducted. The reason of choosing 4th graders was that they had studied this subject previously. Afterwards, validity and reliability process of the study were carried out, and factor analysis was made. Before the factor analysis, appropriateness of the data for factor analysis was tested via Kaiser-Meyer-Olkin (KMO) test. KMO value of the 33 items was found as 0.75. Minimum KMO value required for factor analysis is suggested as 0.50 (Sharma, 1996; as cited by Eroğlu, 2008). The KMO value obtained was found higher than the suggested value. This showed that the data were suitable for factor analysis. 13 items were removed from the test since their eigenvalues were beneath 0.45. The rest 20 items were included in the final form of the test. Cronbach-Alpha reliability coefficient of the test with 20 items was found as 0.84. The final form of the achievement test was applied to 49 4th grade students before and after the intervention.

Creation of concept cartoons

The concept cartoons were prepared in relation with the unit "The Earth Crust and Movements of The Earth" in the 4th grade Science lesson. The concept cartoons were developed regarding students' misconceptions about "The Earth Crust and Movements of The Earth" unit in primary school 4th grade science lesson. With this aim, the misconceptions that the students mostly did were determined by analyzing the studies carried out on this topic. 12 concept cartoons were developed by considering the misconceptions determined and by using ToonDoo cartoon tool. For suitability of the concept cartoons to the students' levels, academic staff working in this area and teachers of science, of class, of visual arts and of information technologies were asked to get their opinions. The students in the experimental group were given training with the concept cartoons developed during 12 h (3 h a week) for four weeks.

Data collection

The data were obtained from the scores the students received from pretest and posttest. The data collection was performed in 3 steps:

Obtaining pretest scores

In the beginning of the study, the test with 20 items developed by the researcher about the unit "The Earth Crust and Movements of The Earth" in primary school 4th grade science lesson was implemented on the students in the experimental and control groups. Pretest scores were determined as a result of the answers that the students gave.

Implementation of the research

Two weeks of the research was spent for the assessment of pretest

and posttest results, and 4 weeks were spent on implementation. The students in the experimental group were taught according to the instruction with concept cartoons while the students in the control group were taught in accordance with the current instructional program. The study lasted for 4 weeks - 3 h per week. The total implementation period was 12 h.

In the classes with the experimental group, the concept cartoons about the lesson were shown to the students. The students spoke on the related concept cartoons, and they discussed them together. At the end of the classes, the students were given the printed concept cartoons, and they were asked to answer the activity questions below the related cartoons. The students who responded incorrectly were corrected, and they were given correct feedbacks.

Obtaining posttest scores

The test with 20 items which was used at the beginning of the research was applied once more to the experimental and control groups as posttest. The students' posttest scores were found as a result of their answers to the posttest questions. Then, pretest and posttest scores of the students in the experimental and control groups were compared. The sample pretest and posttest questions used for the study were as follows:

(1) Which of the following ideas about shape of the earth is proved to be wrong with the fact that an airplane going continuously in the same direction arrives at the same departure after a period of time?

(i) It is round
(ii) It is spherical
(iii) It looks like a ball
(iv) It is flat

(2) Which of the followings is a sign for the fact that the earth is similar to sphere?
(i) Firstly the funnel of a distant ship is seen
(ii) The moon revolves around the earth
(iii) The earth is surrounded by seas
(iv) The earth revolves around the sun

(3) Which of the followings are correct?
(i) Day and night occurs because the earth rotates on its axis.
(ii) Seasons happen because the earth revolves around sun.
(iii) When we see the sunlight it is day, and when we do not it is night.
(iv) I and II (b) I, II and III (c) II and III (d) I and III

(4) Which of the followings cause the creation of day and night?
(i) That the earth revolves around the sun
(ii) That the moon revolves around the earth
(iii) That the earth rotates on its axis
(iv) That the moon rotates on its axis

(5) What is the reason why we see the sun as if it is moving during the day when we look at the sky?
(i) That the earth revolves around the sun
(ii) That the earth is immobile
(iii) That the sun revolves around itself
(iv) That the earth rotates on its axis

In "The Earth Crust and Movements of the Earth" unit of science course, each incorrect answer of the students was scored 0 point and their each correct answer was scored 1 point while evaluating their academic success (Table 1).

Analysis of data

Arithmetic mean, standard deviation, normality test, KMO test and independent groups T-test were employed in data analysis process. Normality test was applied in order to understand if the pretest scores of the students in the experimental and control groups showed normal distribution or not. The experimental group pretest value of skewness was 0,846 and value of kurtosis was -0,290 while the control group value of skewness was 0,472 and value of kurtosis was -0,628. It was regarded that the data showed normal distribution since the pretest values of skewness and kurtosis were between -1 and +1.

Normality test was applied in order to understand if the posttest scores of the students in the experimental and control groups showed normal distribution or not. The experimental group posttest value of skewness was -0,802 and value of kurtosis was 0,450 while the control group posttest value of skewness was -0,459 and value of kurtosis was -0,829.It was considered that the data showed normal distribution since the posttest values of skewness and kurtosis were between -1 and +1.

RESULTS

In this section, the findings related to the impact of instruction with concept cartoons on the students' academic achievement were included.

Results and interpretations related to the first sub-problem

The findings related to the first sub-problem which was "Are there any significant differences between pretest scores of the experimental group students on whom instruction was carried out with concept cartoons and of the control group students on whom instruction was made with conventional method (instruction based on current curriculum) in the unit of "The Earth Crust and Movements of The Earth" in primary school 4^{th} grade science lesson?" are presented in Table 2.

In Table 2, there were not any significant differences between pretest scores of the experimental group students on whom instruction was carried out with concept cartoons and of the control group students on whom instruction was made with conventional method (instruction based on current curriculum) ($T_{(47)}$=-0.91; p=0.36). Thus, it can be stated that the experimental and control group students were equal before the intervention.

Results and interpretations related to the second sub-problem

The findings related to the second sub-problem which was "Are there any significant differences between posttest scores of the experimental group students and of the control group students in the unit of "The Earth Crust and Movements of The Earth" in primary school 4^{th} grade science lesson?" are shown in Table 3.

In Table 3, it was found that there were significant differences between posttest mean scores of the experimental group and of the control group in favor of the experimental group ($T_{(47)}$=-2.74; p=0.00). Therefore, it

Table 1. Implementation in the experimental and control groups.

Groups	Pretests	Experimental procedures	Posttests
Experimental Group	Achievement test about the unit "The Earth Crust and Movements of The Earth" in science lesson	Instruction with concept cartoons	Achievement test about the unit "The Earth Crust and Movements of The Earth" in science lesson
Control Group	Achievement test about the unit "The Earth Crust and Movements of The Earth" in science lesson	Conventional teaching method (current instructional program)	Achievement test about the unit "The Earth Crust and Movements of The Earth" in science lesson

Table 2. T-test results regarding the pretest scores of the experimental and control groups.

Groups	n	$\bar{x}$	S	sd	t	p
Experimental Group	23	46.73	18.43			
Control Group	26	41.53	20.91	47	-0.91	0.36

Table 3. T-test results regarding the posttest scores of the experimental and control groups.

Groups	n	$\bar{x}$	S	sd	t	p
Experimental Group	23	77.60	12.60			
Control Group	26	60.96	26.53	47	-2.74	0.00

can be claimed that the experimental group was more successful than the control group. Additionally, it can be stated that academic achievement of the students in the experimental group on whom instruction was made with concept cartoons was higher than of the students in the control group on whom instruction was carried out with conventional instructional program (Appendix 1).

DISCUSSION

As a consequence of the research, it was found that instruction with concept cartoons was effective in increasing academic achievement of primary school 4th graders in science lesson. When the scores received from the achievement test on "The Earth Crust and Movements of The Earth" by the students in the experimental and control groups were compared, a significant difference was observed in favor of the experimental group. Thus, it is possible to suggest that instruction with concept cartoons was efficient in increasing academic achievement of the students in science lesson.

Conclusion

Conclusions from the research are similar to the conclusions of some previous studies. There are a large number of studies which revealed that instruction with concept cartoons in science education affected students' achievement (Gafoor and Shilna, 2013; Stephenson and Warwick, 2002; Webb et al., 2008; Atasoy and Ergin, 2017; Akdeniz and Atasoy, 2006; Ceylan, 2015, Balım et al., 2009; Akamca and Hamurcu, 2009; Balım et al., 2011; Yavuz and Büyükekşi, 2011; Baysarı, 2007; Evsen, 2013; Taşkın, 2014; Meriç, 2014; Atılğan, 2014; Ocak et al., 2015; Atasayar, 2015; Kabapınar, 2009; Atasoy et al., 2013; Demirel and Aslan, 2014; Gölgeli and Saraçoğlu, 2011). In this regard, the conclusion obtained in the current study is parallel to the conclusions of previous studies.

Several studies revealed that instruction with concept cartoons was efficient (Foley et al., 2011; Rule and Auge, 2005; Chen et al., 2009; Balım et al., 2015). These conclusions are similar to the conclusions of the current study. It can be stated that instruction with concept cartoons is effective because of the fact that instruction with concept cartoons is fun; they are instructing while entertaining, they encourage students to participate in the classes actively and they keep students' attention alive.

Moreover, while many studies suggested that concept cartoons improved students' academic achievement (Keogh et al., 2003; Durmaz, 2007; Eroğlu, 2010; Özüredi, 2009; Evrekli, 2010, Alkan, 2010), some others

claimed that they increased motivation levels of the students during the instructional period (Delisle, 1997; Lou et al., 2010; Dalacosta et al., 2009; Long and Marson, 2003; Naylor and Keogh, 1999; Keogh et al., 1998; İnel and Balım, 2011).

Consequently, both the findings of the current study and the findings of the previous studies have suggested that instruction with concept cartoons in science lesson improved students' achievement. From this aspect, the conclusion of the present study is similar to the conclusions of the previous studies. Concept cartoons make topics visual, increase students' motivation towards lessons, make them active in lessons and make lessons more enjoyable. Thus, instruction supported with concept cartoons is recommended in science lessons to provide students' permanent learning.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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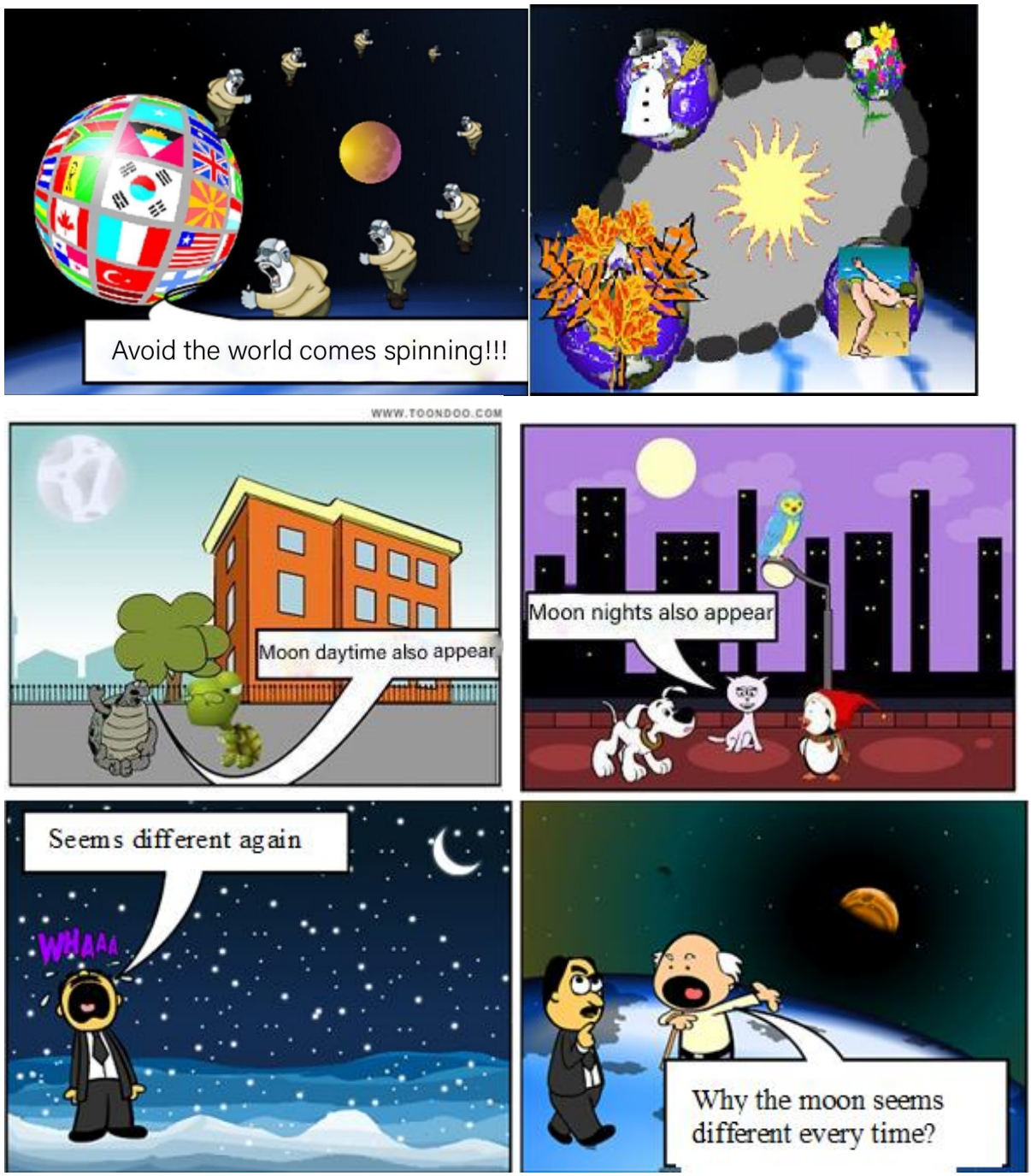
Appendixs



Concept Cartoon Examples

Appendixs. Contd.