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The Effect of Common Knowledge Construction Model on Science Process Skills and Academic Achievement of Secondary School Students on Solar System and Eclipse

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ABSTRACT
The aim of this study is to investigate the effect of Common Knowledge Construction Model (CKCM) on the science process skills and academic achievement of 6th grade students in Solar System and Eclipse (SSE). The study group consisted of 83 students (41 experiment group and 42 control group) studying in 6th grade. In the study, quasi-experimental method was chosen because of the pre-formed classes, and the Solar System and Eclipse Academic Achievement Test (SSEAAT) and the Science Process Skills Test (SPST) were used as data collection tools. Quantitative data obtained by GSTAB and BSBT were analyzed by independent sample t-test, paired sample t-test, one way ANOVA and Pearson product-moment correlation coefficient. As the result of the study, In the courses carried out with the CKCM, a positive increase was observed in the academic achievements of the sixth grade students in the SSE. In addition, students have a positive development in science process skills. It has been determined that students who increase their academic achievements in the SSE unit will also increase their science process skills.
Keywords: Common knowledge construction model, academic achievement, science process skills, solar system and eclipses

Ortak Bilgi Yapılandırma Modelinin Güneş Sistemi ve Tutulmalar Konusunda Ortaokul Öğrencilerinin Bilimsel Süreç Becerileri ile Akademik Başarılarına Etkisi

ÖZET
Bu çalışmanın amacı; Ortak Bilgi Yapılandırma Modeli (OBYM)'nin Güneş Sistemi ve Tutulmalar (GST) konusunda altıncı sınıf öğrencilerinin bilimsel süreç becerileri ile akademik başarılarına olan etkisini araştırmaktır. Araştırmanın çalışma grubunu, 6. sınıfında öğrenim gören 83 öğrenci (41 deney ve 42 kontrol grubu) oluşturmaktadır. Araştırmada yarı deneysel yöntem kullanılmış olup, veri toplama araçları olarak, Güneş Sistemi ve Tutulmalar Akademik Başarı Testi (GSTAB) ve Bilimsel Süreç Becerileri Testi (BSBT) kullanılmıştır. GSTAB ve BSBT ile elde edilen nicel veriler, bağımlı örneklem t-testi, bağımsız örneklem t-testi, tek yönlü varyans analizi (ANOVA) ile analiz edilmiştir. Ayrıca, GSTAB ile BSBT arasındaki ilişki Pearson momentler çarpımı korelasyon katsayısı kullanılarak analiz edilmiştir. OBYM ile gerçekleştirilen derslerde, GST ünitesinde altıncı sınıf öğrencilerinin akademik başarılarında olumlu yönde artış gözlemlenmiştir. Ayrıca öğrencilerin, bilimsel süreç becerilerinde ilerleme kat ettikleri tespit edilmiştir. GST ünitesinde akademik başarıları artan öğrencilerin, bilimsel süreç becerilerinde de artış olduğu tespit edilmiştir. OBYM ile gerçekleştirilen derslerin öğrencilerin bilimsel süreç becerileri ve akademik başarılarına etkisi ortaokul düzeyinde tüm sınıf seviyelerinde araştırılması önerilmektedir.
Anahtar Kelimeler: bilgi yapılandırma modeli, akademik başarı, bilimsel süreç becerileri, güneş sistemi ve tutulmalar

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INTRODUCTION

The dazzling revolution in science and technology has caused various changes in the human profile. The existence of individuals who are able to reach knowledge effectively, efficiently and accurately rather than those who memorize information has gained importance (Kömürcüoğlu, 1995). For this reason, states change their education policies and try to keep up with the 21st century human profile. Ministry of National Education (MONE) has also made various arrangements in the curriculum of Science Education in Turkey. Engineering and design skills have started to take place in the curriculum. Research skills gained importance in the new program. . As a result, besides the notion of being an individual, the concept of the world family has gained importance in the globalizing world and the training of individuals in this direction has been included in the program (Ministry of National Education [MONE], 2018).

One of the basic aims of the science education program is the nature of science. Individuals should be able to use scientific knowledge effectively and to be aware of how scientific knowledge is structured and boundaries (Lederman, 1992). One of the approaches based on the nature of science and the structuring of knowledge is the Common Knowledge Construction Model (CKCM). For this purpose, the use of CKCM in science is thought to be effective (Bakırcı, Çepni & Ayvacı, 2015; Bakırcı, Çepni & Yıldız, 2015; Bakırcı & Çepni, 2014; Ebenezer, Chacko, Kaya, Koya & Ebenezer, 2010; Ebenezer & Fraser, 2001; Kıryak, 2013; Özdemir & Hamzaoğlu, 2015; Taşkın & Yıldız, 2011).

The Common Knowledge Construction Model (CKCM) is an inquiry-based approach to science curriculum. Founded by Ebenezer & Conner (1998), this model incorporates many doctrines. Morton's learning variation, Piaget's schema and conceptual change research, Bruner's approach to language as a symbolic element, Vygotsky's concept of proximal development and Doll's scientific discourse are the basis of the model (Biernacka, 2006; Çepni, Özmen & Bakırcı, 2012; Ebenezer, Chacko, Kaya, Koya & Ebenezer, 2010;). It is a model compatible with phenomenology, which assumes that knowledge is structured as a continuous interaction between man and world (Altun & Vural, 2012; Ebenezer, Chacko, Kaya, Koya & Ebenezer, 2010; Ebenezer & Fraser, 2001). It is thought that the model will contribute to the processes of logic and conceptual change in both natural life and social life. (Ebenezer, Chacko & Immanuel, 2004).

CKCM consists of four stages: Constructing and Negotiating, Exploring and Categorizing, Reflecting and Assessing and Translating and Extending (Bakırcı, Çepni & Ayvacı, 2015). Stages are explained in Table 1:

Table 1. *Common knowledge construction model stages and descriptions*

Stages	Descriptions
Exploring and Categorizing	The attitudes of individuals towards a case are determined. Thus traces of past life are determined and pre-knowledge can be activated. Various visuals, graphics, stories or concept maps can be used to focus students' attention and attention on the subject (Biernacka, 2006; Çepni et al. 2012).
	It is the stage where knowledge is socially structured under the guidance of a teacher. The student focuses on comprehension, thinks about the concept and imagines. Because of the nature of science, he tests his thoughts with observations and analyzes and investigates his scientificity. Students share their ideas with their

Constructing and Negotiating	colleagues with a collaborative approach. Students negotiate and benefit from each other's experiences (Bakırcı & Çepni, 2014; Bakırcı et al. 2014; Biernacka, 2006; Çepni et al., 2012; Ebenezer & Connor, 1998).
Translating and Extending	The concepts that appear in the students' mind are used in different situations at this stage. It is transferred to the situations encountered in daily life. Nature and social events are sought. In this stage, students are expected to produce solutions and negotiate with their peers by providing realistic scenarios (Bakırcı & Çepni, 2014; Bakırcı et al. 2014; Biernacka, 2006; Çepni et al. 2012; Ebenezer & Connor, 1998).
Reflecting and Assessing	The scientific knowledge of the students is questioned. The exchange of concepts and information with scientific facts is supervised. And the process is evaluated with modern measuring tools (Bakırcı & Çepni, 2014; Bakırcı et al. 2014; Biernacka, 2006; Çepni et al. 2012; Ebenezer & Connor, 1998).

Science course, which contains abstract concepts, is a complex structure with many disciplines coming together and this leads to misconceptions (Hürcan & Önder, 2012). Astronomy, which is the subject of this research, is one of the most abstract units with many disciplines such as natural sciences, socio-sciences, mathematics, physics, chemistry and biology (Göncü & Korur, 2012). CKCM has been shown to be effective model in mathematics (Taşkın & Yıldız, 2011), science teaching (Bakırcı & Ensari, 2018) and the understanding of nature of science (Biernacka, 2006). In this context, it is thought that CKCM can simplify abstract content and the concepts will be given to the students correctly.

Scientific process skills are used in structuring knowledge and analyzing results. With the help of this skill, students can help to make sense of the outside world with their inner world (Abd-El-Khalick & Lederman, 2000; Akerson et al., 2000; Carey et al., 1989; Lawson, 1982).

The nature of science and science process skills are interrelated and it is thought that students will develop in both themes with the inclusion of the process (Lawson, 1982; McComas, 1993; Moss et al. 1998). Students can improve the mentality of the nature of science only by applying scientific activities. It was determined that the sixth grade students of CKCM were effective on the nature of science (Bakırcı et al., 2017). The aim of this study was to investigate the development of science process skills of the students who developed the nature of science.

As a result of the literature on CKCM, it is seen that there is limited study on this approach. Table 2 also summarizes the research on CKCM:

Table 2. *Research on the common knowledge construction model*

Author	Topics	Class	Participant	Result
Bakırcı & Çepni (2012)	-	-	-	Document analysis of the Common Knowledge Construction Model was made and the basics of the model were examined.
Bakırcı, Çepni & Ayvacı (2015)	Qualitative interview	Science teacher	15 teacher	They found that students spent a lot of time in The Exploring and Categorizing stages and stated that

				teachers should explain more about concepts.
Bakırcı, Çepni & Yıldız (2015)	Light and Sound	6th grade	76 students	It was observed that the academic achievement of the students increased positively.
Bakırcı, Özmen & Çepni (2012)	Light and Sound	6th grade	121 students	CKCM and 5E learning model was determined that students achieved an equal increase in academic achievement. It was also determined that the CKCM and 5E learning model provided an equal increase in the students' logical thinking skills. However, they concluded that they were more successful than traditional methods.
Biernacka (2006)	Weather events	-	1 teacher	There was a positive development in the scientific literacy of the students and the level of awareness in the field of Science-Technology-Society-Environment increased.
Demircioğlu & Demircioğlu (2012)	Acid-bases unit	6th grade, 7th grade and 8th grade	29 students	It has been observed that the students' academic successes have been increased, the skills to associate concepts have improved and the conceptual changes have improved.
Ebenezer & Fraser (2001)	Energy changes	Grade-1 students in chemical engineering	17 students	It is stated that it will be useful in teaching cases and concepts.
Ebenezer et al. (2010)	Discharge unit	7th grade	68 students	It was observed that the academic achievement of the students increased positively.
Güngören (2015)	Nature of Science and History of Science	3th grade	41 science teacher candidate	They explained that there is a positive development in students', opinions and knowledge levels, awareness about the nature of science.
İyibil (2011)	Energy	7th grade	42 students	There was an increase in students' academic achievements and progress in their conceptual changes.
Kıryak (2013)	Water pollution	7th grade	25 students	The language used in the daily life of the students was compared with the scientific language, the conceptual changes were examined and as a result positive changes were explained.
Özdemir (2014)	Structure of Atom, Light, Human and Environment, Sound, State of Matter and	7th grade and 8th grade	87 students	In this study comparing CKCM with 5E model, it was stated that according to the 5E of CKCM, students showed moderate improvement in academic

	Heat and Energy Resources and Recycling			achievement, concept change and nature of science.
Özdemir and Hamzaoğlu (2015)	Three different science units	7th grade and 8th grade	87 students	It was observed that the 7th grade students' conceptual changes were more pronounced than the 8th grade students.
Taşkın & Yıldız (2011)	Addition and subtraction in fractions	6th grade	32 students	Materials have been developed with addition and subtraction in fractions, and as a result of preliminary research, it has been suggested to use these materials in mathematics courses.
Wood (2012)	Acid-bases unit	High school student	39 students	It has been observed that there is progress in explaining concepts and conceptual changes.

When the studies about CKCM were examined, it was observed that the students increased their academic achievement, facilitated their understanding of the concepts, provided easier conceptual changes, increased logical thinking skills and gained more effective scientific language. Research shows that CKCM is suitable for use in science courses. When the studies about CKCM were examined, there was no study in the Solar System and Eclipse Unit at the sixth grade level. In addition, there is no study measuring the effect of common knowledge configuration model on scientific process skills. In this context, the purpose of this research is to investigate the effect of CKCM on sixth grade students in Solar System and Eclipse unit on science process skills and academic achievement.

The following questions were examined in this research:

1) What is the effect of the CKCM on the sixth grade students' academic achievements in Solar System and Eclipse?

2) What is the effect of the CKCM on the sixth grade students' science process skill in Solar System and Eclipse?

3) Is there a relationship between science process skill and academic achievement of the sixth grade students in Solar System and Eclipse?

METHODOLOGY

Research Design

In this study, a quasi-experimental model was used. Experimental patterns are a model based on experiment and observation, which facilitates the researcher to establish the cause-effect relationship on the cases, to keep the desired variables constant or to change (Fraenkel & Wallen, 2009). In the school where the study was conducted, the groups were studied with the existing classes which were not assigned by random method, but the equivalence of the groups was checked with preliminary analyzes. Pre and post tests will be applied to the experimental and control groups. The design of the study can be described in more detail as a pre test-post test control grouped pattern. The experimental group conducted the courses according to the common knowledge construction model and the control group carried out the courses according to the current program.

Sample

In this research was go through with 83, 6th grade students (41 students in the experimentan group and 42 students in control group) studying at a secondary school in Yakutiye district of Erzurum during 2018-2019 academic year. The experimental group consisted of 22 male and 19 female students; the control group consisted of 23 male and 19 female.

The sample of the research was choosen by the convenience sampling method from non-random sampling methods (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz & Demirel, 2011). Convenience sampling is a method that facilitates the researcher when there are restrictions in terms of money, time and labor (Yıldırım & Şimşek, 2011).

Data Collection Tools

In this study, the Solar System and Eclipse Academic Achievement Test (SSEAAT) and the Science Process Skills Test (SPST) were used as data collection tools. In the preparation of SSEAAT, the achievements in the Science Education Curriculum were taken into consideration. The questions are prepared by creating a specification table. During the preparation of the questions, the student level was taken into consideration and the questions were shaped according to the teachings of CKCM.

It is recommended that modern measurement and assessment techniques be used in the reflecting and assessing stages of the CKCM. For this reason, while preparing questions, structured grid, word association test, concept map, diagnostic branched tree and concept cartoons are included. The SSEAAT is a test of multiple choice question. The test consists of 25 items and each item has four options. Finally, three experienced science teachers were consulted. The pilot application of the measurement tool was applied to seventh grade students who had previously learned this subject. The correct answers of the students to the questions were coded as '1', the wrong answers and the blank answers were coded as '0'. The KR-20 reliability coefficient of the developed academic achievement test is 0.83, indicating that the test is a reliable measurement tool. (Büyüköztürk, 2011).

The SPST used in the research was developed by Aydoğdu, Tatar, Yıldız & Buldur (2012) and consists of 27 multiple choice questions. 18 of the items are prepared for high-level skills, and 9 for basic skills. The distribution of substances is summarized in Table 3:

Table 3. *Science Process Skills Test item distribution*

Science Process Skills	**Science Process Skills Sub-Dimensions**	**Science Process Skills Test Item Number**
Basic Science Process Skills	Observation	1, 2
	Classification	3, 4
	Space / Time Relationship	14, 27
	Guess	7
	Inference	5, 6
High level Science Process Skills	Determining the Problem	16, 22
	Hypothesis	10, 11, 17, 23
	Determining Variables	18, 19, 20, 24, 25
	Experimentation	8, 12, 13, 15, 21
	Data Interpretation	9, 26

For the reliability of the test, pilot application was carried out and cronbach α reliability coefficient was found to be .80.

The Solar System and Eclipse Academic Achievement Test (SSEAAT) and Science Process Skills Test (SPST) will be applied as pre-test and post-test to all groups. In addition, SSEAAT will be applied as a permanence test for both groups. Table 4 summarizes the data collection process:

Table 4. *Data collection process*

Group	Pretest	Posttest	Permanence test
Experimental Group	The Solar System and Eclipse Academic Achievement Test (SSEAAT) Science Process Skills Test (SPST)	The Solar System and Eclipse Academic Achievement Test (SSEAAT) Science Process Skills Test (SPST)	The Solar System and Eclipse Academic Achievement Test (SSEAAT)
Control Group	The Solar System and Eclipse Academic Achievement Test (SSEAAT) Science Process Skills Test (SPST)	The Solar System and Eclipse Academic Achievement Test (SSEAAT) Science Process Skills Test (SPST)	The Solar System and Eclipse Academic Achievement Test (SSEAAT)

Materials Development and Pilot Application

As the Solar System and Eclipse unit are abstract concepts for students, there are many misconceptions among students. For example; “The shape of the stars is similar to the star on the Turkish flag”, “Meteor and meteorite are the same concepts” (Şahin, Bülbül & Durukan, 2013), “Comets are also stars”, common misconceptions. Alternative concepts were prepared before the implementation. These alternative concepts have been placed by the researcher in diagnostic branched tree, structured grid, word association test, concept map and concept cartoons. Three experts were consulted about the materials. In addition, the materials were presented to two students who had a PhD in science teaching. Finally, three experienced science teachers were consulted.

In order to gain experience of the researcher and to test the instructional materials prepared according to the CKCM, a pilot study was conducted. The pilot study was carried out with the participation of 73 students from the Palandöken district of Erzurum. The pilot application lasted for approximately three weeks and the courses were recorded by observation form.

As a result of the pilot study, the materials for which the students were forced were changed according to the expert opinion. As a result of the pilot study, language disorders and typographical errors in the materials were arranged by taking the opinions of a Turkish teacher. It was determined that the use of black and white colors in materials negatively affected the intelligibility and it was decided to use colored materials for the actual application. In addition, the part about the surface properties of the sun was removed from the teaching materials because it contained more detail. After all necessary arrangements were made as a result of the pilot study, the actual application was started.

Application

In the research, there are two groups as experimental and control groups. In the experimental group, CKCM-based science teaching was applied; in the control group, courses were conducted according to the curriculum-oriented science teaching. The research took about

five weeks. In the first lesson of the experimental group, CKCM was introduced and students were mentally prepared. The Solar System and Eclipse unit consists of two sub-gains, Solar and Lunar Eclipses. The following table presents a sample lesson plan suitable for the sub-gain of the Solar System. The activities of the control group were taken from the textbook proposed by MEB. The activities of the experimental group were developed by the researcher.

The course processing process in the control group, respectively: “What are the names of round celestial bodies circulating around the sun in their own orbits?” The question has been directed to students. After the answers of the students, the reading part of the textbook “The Planets in The Solar System” were read by the students and their ideas were taken. “What are the structural features of the planets?” The question has been directed to students. After the answers of the students, the reading part of the textbook “Structural Properties of Planets” were read by the students and their ideas were taken. “What are the names of the celestial bodies that rotate with them around some of the planets in the solar system?” The question has been directed to students. In the textbook, the distances of the planets to the sun were examined by the students. “What is called the solid objects that come from space, enter the Earth's atmosphere and burn as a result of rubbing against the substances in the atmosphere? How is this event known among the public?” The question has been directed to students. After the answers of the students, the reading part of the textbook “Meteorites and Meteors” were read by the students and their ideas were taken. Students were asked to research the meteor pits and present them in the classroom. “What is the difference between meteorites and celestial bodies called asteroids?” The question has been directed to students. The text named “Do you know these?” in the textbook was read by the students and students felt a sense of curiosity. The students were asked to perform their “Let's Make a Solar System Model” activity. The students who applied “Working Time-1” activity were provided with a better understanding of the unit. The “What have we learned?” section in the textbook was examined by the students and the topic was summarized. With the “Unit Evaluation-1” test, the students had the opportunity to test what they had learned.

The course processing process in the experimental group, respectively: “The Remember” activity was performed to reveal the students' prior knowledge. The story of “The Space Adventure” in the worksheet was read to the students and the open-ended questions were directed to the students. “Sputnik-1” space simulation based on the nature of science mobilized students' preliminary information. The students were asked to prepare their own mind maps to bring their knowledge together. And they were asked to share these mind maps with their friends. Students were asked to fill out the work papers “Planets in the Solar System” and “Satellites in the Solar System.” Concept changes were made with the help of concept cartoons. Students were provided with the opportunity to exchange ideas with the panel they organized. The students explored the ideas about the solar system and presented them in the classroom. Thus, scientists were able to explore the reasoning techniques and have an idea about the nature of science. The students were able to fill the structured gradient given to them and share the results with each other. Students were given “A Day in Space”” text and discussed with the method of Socratic discussion. With the guidance of the teacher, the class was divided into two and the opposite panel was applied and the students were provided with the opportunity to exchange ideas. Social development of students supported. Students were asked to test “The Space Studies Under Water” experiment and to conduct research in similar environments. The students were asked to establish an analogy between concepts and to share these analogies with each other. “What planet there is life?" activity was applied to connect with daily life. In order to expand what they have learned, students were provided with the solution to the problem in the text of “Meteor and the End of the World”. The students were given the opportunity to solve the test consisting of diagnostic branched tree, structured grid, word association test, concept

map and concept cartoons. Table 5 presents an example lesson plan for the experimental and control group course work:

Table 5. *Experimental and control group sample lesson plan*

Control Group	*Experimental Group*
Preparation question	Remembering the preliminary information
Read text	Story and inquiry
Extender question	Simulation
Read text	Mind map
Extender question	Worksheet
Source research	Concept cartoon
Extender question	Panel
Read text	Structural grids
Research and presentation	Socratic discussion
Extender question	Contrasting panel
Read text	Experiment
Activity	Analogy
Application	Activity
Topic Summary	Problem solving
Evaluation test	Authentic assessment

Data Analysis

Data obtained from the test were transferred to SPSS 24 package program. The data were analyzed in terms of normal distribution, distortion and kurtosis values and graphs. After the descriptive analysis, the data were normally distributed. One-way analysis of variance (ANOVA) was used to analyze whether there was a significant difference between the results of the experimental and control groups (Pallant, 2013). In addition, data were analyzed with ANOVA to increase reliability. In addition, the relationship between SSEAAT and SPST was analyzed using Pearson product-moment correlation coefficient.

RESULTS

First Sub-Problem Results

The first sub-problem of the study was applied to "The Solar System and Eclipse Academic Achievement Test (SSEAAT)" to look for the "What is the effect of the CKCM on the sixth grade students' academic achievements in Solar System and Eclipse?" question. One-way analysis of variance was performed to determine whether there was any difference between pretest, posttest and permanence test scores of experimental group students. As the result of Levene test was less than $p < 0.05$, the assumption of variance equation was not provided. Therefore, Games-Howell test was used for multiple comparison tests.Table 6 shows the ANOVA results of the pre test, post test and permanence test scores of the experimental group students:

Table 6. *One-Way ANOVA results of pre test, post test and permanence test scores of experimental group*

Source of Variance	Sum of Squares	df	Mean Square	F	p	Difference
Between Groups	2543,431	2	1271,715	134,043	.000	Post Test > Pre Test Permanence> Pre Test
Within Groups	1138,488	120	9,487			
Total	3681,919	122				

The ANOVA results as shown in Table 6, revealed that the mean achievement scores of pre test, post test and permanence test were significantly different [F(2, 120) = 134.043, p <.05]. According to the Games-Howell tests, the mean differences in achievement test between the pre test and post test were found to be statistically significant. As a result of the multiple comparison test, it is understood that the significant difference between ($\bar{X}$ = 11,43) the pre test and ($\bar{X}$= 21,09) post test is in favor of the post-test and between the ($\bar{X}$= 11,43) pre test and ($\bar{X}$ = 21,07) permanence test is in favor of permanence test. Also, there was no significant difference between post test and permanence test. The eta square (η^2) was investigated to determine the effect size. Cohen (1988), if η2<.80, it is grouped as moderate. The impact size was moderate (η2=.69).

One-way analysis of variance was performed to determine whether there was any difference between pretest, posttest and permanence test scores of control group students.
As the result of Levene test was greater than p> 0.05, the assumption of variance equation was ensured. Therefore, Tukey test was used for multiple comparison tests. Table 7 shows the ANOVA results of the pre test, post test and permanence test scores of the control group students:

Table 7. *One-Way ANOVA results of pre test, post test and permanence test scores of control group*

Source of Variance	Sum of Squares	df	Mean Square	F	p	Difference
Between Groups	407,254	2	203,627	34,402	,000	Post Test > Pre Test Permanence Test> Pre Test
Within Groups	728,048	123	5,919			
Total	1135,302	125				

The ANOVA results as shown in Table 7, revealed that the mean achievement scores of pre test, post test and permanence test were significantly different [F(2, 123) = 34,402, p<.05]. According to the Tukey tests, the mean differences in achievement test between the pre test and post test were found to be statistically significant. As a result of the multiple comparison test, it is understood that the significant difference between ($\bar{X}$ = 11,78) the pre test and ($\bar{X}$ = 15,78) post test is in favor of the post-test and between the ($\bar{X}$ = 11,78) pre test and ($\bar{X}$ = 15,38) permanence test is in favor of permanence test. Also, there was no significant difference between ($\bar{X}$ = 15,78) post test and ($\bar{X}$ = 15,38) permanence test. The eta square (η^2) was investigated to determine the effect size. Cohen (1988), if η2<.80, it is grouped as moderate. The impact size was moderate (η^2=.35).

Second Sub-Problem Results

The second sub-problem of the study was applied to “Science Process Skills Test (SPST)” to look for the “What is the effect of the CKCM on the sixth grade students' science process skill in Solar System and Eclipse?” question.

Independent t-test was used to compare the experimental and control groups. The results of the pre-test, post-test and permanence test of the experimental and control groups are given in Table 8:

Table 8. *Independent t-test results for SPST pre-test and post-test scores of experimental and control groups*

TEST	GROUP	N	$\overline{X}$	ss	df	t	p
Pre Test	Experimental	41	12,21	3,99	81	-,787	,433
	Control	42	12,85	3,36			
Post Test	Experimental	41	22,53	3,36	81	6,926	,00
	Control	42	17,30	3,50			

As demonstrated in Table 8, there was no significant difference between the pre-test average ($\bar{X}$=12.21) of the experimental group and the pre-test average ($\bar{X}$=12.85) of the control group [t(81)=-.787, p>.05]. In the light of the findings, it seems that the groups were close to each other in terms of Scientific Process Skills.When Table 10 is examined, there was significant difference between the post-test average ($\bar{X}$=22.53) of the experimental group and the post-test average ($\bar{X}$=17.30) of the control group [t(81)=6,926, p<.05]. In the light of the findings, the experimental group in the Solar System and Eclipse Unit seems to be more successful after the application. Table 9 shows the comparison of the pretest and posttest scores of the experimental and control groups with the paired t-test.

Table 9. *Paired t-test results of SPST pre-test and post-test scores of experimental and control groups*

TEST	GROUP	N	$\overline{X}$	ss	df	t	p
Experimental	Pre Test	41	12,21	3,99	40	-13,34	,00
	Post Test	41	22,53	3,36			
Control	Pre Test	42	12,85	3,36	41	-5,84	,00
	Post Test	42	17,30	3,50			

As demonstrated in Table 9, there was significant difference between the pre test average ($\bar{X}$=12.21) of the experimental group and the post test average ($\bar{X}$=22.53) of the experimental group [t(40)=-13.34, p<.05]

There was significant difference between the pre test grades average ($\bar{X}$=12.85) of the control group and the post test grades average ($\bar{X}$=17.30) of the control group [t(41)=-5,84, p<.05].

Third Sub-Problem Results

For the answer to the "Is there a relationship between academic achievement and scientific achievement skills of the sixth grade students in Solar System and Eclipse?" question, which is the third sub-problem of the study, the correlation results between SSEAAT and SPST scores were analyzed. Results are presented in table 10:

Table 10. *Pearson correlation results between SPST and SSEAAT scores of experimental group ve control group students*

Group	Test	SPST	SSEAAT
Experimental group	Science Process Skills Test (SPST)	1	,961**
	Solar System and Eclipse Academic Achievement Test (SSEAAT)	,961**	1
Control group	Science Process Skills Test (SPST)	1	,434**
	Solar System and Eclipse Academic Achievement Test (SSEAAT)	,434**	1

** The mean difference is significant at the 0.01 level.

The relationship between the Solar System and Eclipse Academic Achievement Test (SSEAAT) and the Science Process Skills Test (SPST) was analyzed using the Pearson product-moment correlation coefficient (Table 10). Normality tests, linearity, and variance assumptions were examined and checked. In the experimental group, a strong and plus correlation was found between the two variables, r = 92, n = 166, p <.001. In the light of the findings, it is seen that the students in the experimental group who increase their academic achievement in the Solar System and Eclipse unit will also increase their science process skills. In the control group, a moderate and positive correlation was found between the two variables, r = 43, n = 84, p <.001. According to these results, it is seen that the students in the control group who increase their academic achievement in the Solar System and Eclipse unit will also increase their science process skills. However, the increase in the number of students in the experimental group is higher.

DISCUSSION AND CONCLUSION

The aim of this study is to investigate the effect of Common Knowledge Construction Model (CKCM) on the science process skills and academic achievement of 6th grade students in Solar System and Eclipse. At the beginning of the study, experimental and control groups were found to be similar in terms of both academic achievement and science process skills.

There was a statistically significant difference between the SSEAAT and SPST pre test and post test scores of the experimental and control groups, and this difference was in favor of the post test. The findings show us that both methods have an effect on students' academic achievement and science process skills. This situation was observed in similar studies (Bakırcı, Çepni & Yıldız, 2015). When the effect sizes of experimental and control groups are examined, it is observed that the effect in experimental group is larger. In addition, when the findings are examined, it is seen that the CKCM applied in the experimental group leads to a further increase in students' academic achievement and permanence levels according to the program-oriented science teaching applied in the control group The findings show that CKCM may be more effective in the permanence of knowledge. In a similar situation, Ebenezer et al. (2010) stated that CKCM increased the academic achievement of students. In addition, Bakırcı & Çepni (2014) stated that this achievement could be due to the fact that the use of different teaching techniques in OBMD prevented the misconceptions that may or may not be possible in the students.

The achievement of the control group students increased. This results can be clarified by the fact that research and inquiry-based instruction is student-centered, that the science textbook is involved in various activities and that it is process-oriented (Bozkurt et al., 2013). When the literature is examined, it has been shown that the current program has a positive effect

on students' academic achievement (Akpullukçu, 2011; Bağcaz, 2009; Bozkurt et al., 2013; Çelik & Çavaş, 2008; Duban, 2008; Taşkoyan, 2008; Tatar, 2006)

The findings explain that the experimental group students' knowledge in the Solar System and Eclipse Unit is permanent and that the forgetting is not visible. The findings show that there may be forgetting in the control group students and their knowledge is not permanent. The research shows us that the common knowledge configuration model provides information permanence. Examining the literature, the CKCM shows us that there is a positive progress in students' academic achievement (Bakırcı & Ensari, 2018; Brown & Ryoo, 2008). In the multiple comparison tests, a statistically significant difference was found in favor of permanence test between pre test and permanence test. These findings show that the experimental group students progressed academically and preserved their knowledge. In addition, no significant difference was found between the post test and permanence test. This shows that the CKCM provides persistence in students' knowledge. The eta square (η^2) was investigated to determine the effect size. Cohen (1988), if $\eta 2<.80$, it is grouped as moderate. The impact size was moderate ($\eta 2=.69$). As a result of the multiple comparison test, it is observed that the significant difference between the pre test and the post test is in favor of the post test (Table 8). This shows that research and inquiry-based science teaching has positive progress in students' academic achievements. In the multiple comparison tests, a statistically significant difference was found in favor of permanence test between pre test and permanence test. These findings show that the control group students progressed academically. There was also a significant difference between the last test and permanence test in favor of the final test. This shows that there may be forgetting among the control group students. The eta square (η^2) was investigated to determine the effect size. Cohen (1988), if $\eta 2<.35$, it is grouped as moderate. The impact size was moderate ($\eta 2=.69$). The effect size of the experimental group students' academic achievement scores was higher than the control group students. Similar situations are seen in the literature (İyibil, 2011; Wood, 2012).

According to the independent sample t test results of the Science Process Skills (SPS), there was no statistically significant difference between the SPS pre test achievement average of the students who applied the courses of the Common Knowledge Consruction Model (CKCM) and the pre test achievement average of the students who applied their courses with the current program (Table 8). In the light of the findings, it seems that the groups were similar to each other in terms of Science Process Skills. According to the paired sample t test results of the Science Process Skills, there was statistically significant difference between the SPS post test achievement average of the students who applied the courses of the Common Knowledge Consruction Model (CKCM) and the post test achievement average of the students who applied their courses with the current program (Table 9). In the light of the findings, experimental group seems to be more successful than the control group in terms of scientific process skills after application. When the findings are examined, it is seen that the Common Information Configuration Model applied in the experimental group leads to a greater increase in the scientific process skills of the students according to the program-oriented science teaching applied in the control group (Table 9). The reason of the increase in the control group may be that research and inquiry-based science teaching is effective in the students' scientific process skills (Köksal, 2008; Parim, 2009; Yaşar & Duban, 2009; Yıldırım, 2012). According to Biernacka (2006), the reason for the experimental group students is that the CKCM leads to a positive development in the students' scientific literacy and increases awareness levels in the field of Science-Technology-Society-Environment (STSE). In this context, it can be said that the development of science process skills of individuals who develop in scientific literacy will be improved. Again, Özdemir (2014) & Güngören (2015) explained that the CKCM will ensure

the progress of students in the nature of science. The nature of science and science process skills are closely related and it shows that CKCM can contribute to students in this theme.

The relationship between the Solar System and Eclipse Academic Achievement Test (SSEAAT) and the Science Process Skills Test (SPST) was analyzed using the Pearson product-moment correlation coefficient. As a result of the analyzes, a strong and positive correlation was found between the two variables (r = 92, n = 166, p <.001). According to these results, it is seen that the students in the experimental group who increase their academic achievement in the Solar System and Eclipse unit will also increase their science process skills (Table 12). According to Cohen (1988), it is shows high corelation (η2<.80).

Among the control group students, there was a moderate and positive correlation (r = 43, n = 84, p <.001) between the two variables (Table 13). According to these results, it is seen that the students who increase their academic achievement in the Solar System and Eclipse unit will also increase their science process skills. At the same time, this relationship shows that the experimental group students have a stronger and greater effect than the control group students. The reason of this high correlation in the experimental group is also seen in the literature in which CKCM advances students in scientific subjects (Bakırcı & Çepni, 2012; Biernacka, 2006; Güngören, 2015; Özdemir, 2014; Vural et al., 2012). As a matter of fact, it was observed that activities in CKCM strengthened cognitive structure and prevented misconceptions. It is also emphasized that it is effective in conceptual understanding (Çepni et al., 2012). This explains the positive relationship between academic process skills and academic achievement in the experimental group (Kiryak, 2013).

RECOMMENDATIONS

It has been observed that the CKCM has an impact on academic achievement and science process skills of sixth grade students in Solar System and Eclipse Unit. The use of CKCM in other science units is thought to be effective on students' academic achievement and science process skills. CKCM has been observed to be effective in science teaching in various studies (Bakırcı et al., 2017; Biernacka, 2006; Ebenezer et al., 2004). In this context, in-service training should be given to science teachers about CKCM and teachers should be braveried to use this model. In this research, it is thought that the use of instructional materials and lesson plans developed for the Solar System and Eclipse units will be used by science teachers, students will improve their academic success and develop their scientific process skills.

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