THE EFFECT OF AUGMENTED REALITY AND MOBILE APPLICATION SUPPORTED INSTRUCTION RELATED TO DIFFERENT VARIABLES IN 7TH GRADE SCIENCE LESSON[8]

Abstract: The purpose of this study is to investigate the effect of augmented reality and mobile application supported instruction on students' academic achievement, attitude towards astronomy, anxiety and motivation towards learning science in the "Solar System and Beyond/Earth and Universe" units in seventh grade Science lesson. In the study, pre-test-post-test control group quasi-experimental design was used. The study group consisted of 56 students (29 students in the experimental and 27 students in the control group) selected with the convinience sampling method, who were studying in 7th grades of a secondary school in Hatay province, Turkey. Data was collected through the "Solar System and Beyond Success Test" (SSBST) developed by the researcher; "Science Learning Anxiety Scale" (SLAS) developed by Yıldırım (2015) "Astronomy Attitude Scale" (AAS) developed by Zeilik, Schau and Mattern (1999) and adapted into Turkish by Bilici, Armağan, Çakır and Yürük (2012) and "Students' Motivation Scale for Science Learning" (SMSS) developed by Tuan, Chin and Shieh (2005) and adapted to Turkish by Yılmaz and Çavaş (2007) was used. The data were analyzed using descriptive statistics as the mean, standard deviation, frequency percentage values, and the inferential statistics as dependent and independent t-tests. As a result, it was found that mobile application and augmented reality supported instruction had a positive impact on academic success, did not have any effect on anxiety and motivation towards the lesson, and negatively affected attitude towards the content according to the methods suggested by the current program.

Keywords: Science Teaching, Augmented Reality, Mobile Application, Solar System, Academic Success, Attitude Towards Astronomy, Motivation, Anxiety.

Coşkun, Mehmet, PhD
Teacher
Science Education
Hatay Mustafa Kemal Üniversity
Turkey
Contact:
E-mail: m_coskun2@hotmail.com
ORCID: 000-0003-4838-0869

Koç, Yasemin, PhD
Assist. Prof. Dr.
Science Education
Hatay Mustafa Kemal Üniversity
Turkey
Contact:
E-mail: yaseminkoc83@hotmail.com
ORCID: 0000-0003-4918-9054

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INTRODUCTION

In today's world, the rapid development of science and technology causes some changes in human lives (Akkoyunlu, 1998). The fact that people are affected by this development has also affected the instructional environments. From past to the present, the transition from chalkboards to interactive whiteboards in instructional environments is an indicator of how fast the change occurs in technology. Educational implementations developed for use on desktop computers, tablets and mobile phones enrich students' imaginations, embody intangible concepts and add excitement to learning with the help of various multimedia elements combined (Timur & Özdemir, 2018). The differentiation of technological applications and the development of mobile technology have revealed the concept of mobile learning. Mobile learning is that learners can access to education, training content in different environments, with various tools and wireless networks (Moldovan, Weibelzahl & Muntean, 2014). Quinn (2000) defined mobile learning as an e-learning environment realized with computers, tablets and smart mobile phones. Using mobile devices in education the advantages such as creating an out-of-school learning environment, easy access to information resources for students in different environments, saving time, discovering information with concrete experiences, enabling repetition, reaching a result without a dangerous situation (such as experiments in science subjects that can endanger human health) and reaching real solutions to problems are an undeniable reality (Behera, 2013; Bayraktar & Kaleli, 2007). In addition, augmented reality (AR), which can be used in mobile or non-mobile devices, takes important steps towards becoming one of the innovative technologies that are thought to contribute to today's learning environments (Özdemir, 2017). Cai, Chiang & Wang (2013) defines AG as the transfer of 2D and 3D virtual objects produced in computer environment to the user environment., using human computer interaction techniques, 3D graphic technology, various visual perception technologies and multi-media methods. AR is also defined as transferring the existing reality to virtual environment by supporting it with pictures, video, animation and 3D (Demirer & Erbaş, 2015). Thanks to AR, it provides the opportunity to model some features (magnetic field, current, energy, etc.) that cannot be seen with the eye in the real world, to be modeled in three dimensions and numerically, to present information together with real world entities, and to concretize some intangible concepts (Timur & Özdemir, 2018).

When the literature on the subject is examined, it is seen that the use of AR in educational environment has many contributions in both cognitively and effectively. Use of AG provides contributions such as to learn by building/doing by transforming to concrete from intangible (Chiang, Yang & Hwang, 2014; Wang, Duh, Li, Lin & Tsai, 2014), to learn by inquiry, improving their creativity by influencing their imagination (Aktamış & Arıcı, 2013), to enable students to participate in the lesson by increasing their concentration (Delello, 2014; Dede & Yaman, 2008; Wolters & Rosenthal, 2000), to support cooperative learning (Timur and Özdemir, 2018), to increase positive attitude and maotivation, (Çavaş, Huyugüzel & Can, 2004; Ersoy, Duman & Öncü, 2016; Uluyol & Eryılmaz, 2014; Onbaşılı, 2018; Delello, 2014; Chiang, Yang & Hwang, 2014; Furió, Juan, Segui & Vivó, 2015; Perez-Lopez & Contero, 2013; Solak & Cakir, 2015; Timur & Özdemir, 2018; Huang, Chen & Chou 2016) and to alleviate anxiety (Çavaş, Huyugüzel & Can, 2004). It is stated in the studies of the education that motivation is effective on the concepts that have critical roles in the learning process such as success, critical thinking, and high-level thinking skills, and highly motivated students participate in the lesson more (Dede & Yaman, 2008; Wolters & Rosenthal, 2000). This situation reveals the necessity of keeping students' motivation high. Another affective factor that has an important effect on the learning process is attitude. Attitude can be defined as the pre-tendency that an individual has about any subject. The attitude directs the individual's behavior by causing the individual to behave biased in the decision-making process (Nuhoğlu, 2008). It can be said that it is one of the most important contributions to increase the success of the students with the effect of the mentioned these contributions. When the studies on AR applications are examined, it is seen that intangible concepts are widely used in science courses where there are a lot of them and they provide the stated contributions (Abdüsselam & Karal, 2012; Abdüsselam, 2014; Ibáñez, Di Serio, Villarán & Kloos, 2014; Zhang, Sung, Hou & Chang, 2014; Wojciechowski & Cellary, 2013; Wang, Duh, Li, Lin & Tsai, 2014; Chen & Wang, 2015; Hsiao, Chen & Huang, 2012; Timur & Özdemir, 2018).

Science, by its nature, consists of the facts and events that we live and experience in life. Despite this, the science course is one of the courses with low academic achievement due to this least understood and not so liked by students (Timur, Timur, Özdemir & Şen, 2016). This situation may indicate reasons such as the

fact that science subjects are intangible and cannot be given in relation to daily life. Subjects that are not given in relation to the daily life of the student prevent the internalization of knowledge. To understand abstract scientific concepts, students need to create mental models (Ibáñez, Di Serio, Villarán & Kloos, 2014). The fact that there are abstract and difficult to visualize concepts such as astronomy subjects in science classes causes these subjects to be perceived as belonging to invisible worlds (Anagün, Ağır & Kaynaş, 2010; Taşdemir & Demirbaş, 2010; Canpolat & Ayyıldız, 2019). In this context, it is thought that effective use of innovative technologies such as augmented reality (AR) and mobile applications in science lessons will be beneficial in achieving gains (Timur & Özdemir, 2018).
This study aims to investigate the effect of applying augmented reality and mobile applications in teaching astronomy in terms of different angles. Computer software used in the field of astronomy is based on the use of the computer in educational environments. However, the history of professional astronomy programs covers the last 20 years (Gülseçen, 2002). Astronomers test the proposed theories in virtual environments created by simulation programs. These virtual environments guide scientists working in this field to better see the formation of the Solar System and the planets, and the changes that have occurred years later. Therefore, In this study, it was aimed to examine the effect of teaching supported by augmented reality and mobile applications in the seventh grade Science lesson "Solar System and Beyond / Earth and Universe" unit on students' academic achievements, attitudes towards astronomy and anxiety and motivation towards learning science . This study differs in terms of determining the effects of augmented reality and mobile applications on many variables such as success, attitude, anxiety and motivation in a study.

METHOD

In the study, pre-test-post-test unequaled control group quasi-experimental design one of the quantitative research methods was used. As required by the quasi-experimental design, the groups were determined as one experiment group and the other as control group, by random assignment. Students in the experimental and control groups cannot be randomly created since the classes of the students are determined beforehand and the students cannot switch between classes (Fraenkel & Wallen, 2000). The pretest-posttest unequaled control group quasi-experimental design used in the study is given in Table 1.

Table 1. The pretest-posttest unequaled control group quasi-experimental design

Groups	Pretest	Implementation	Posttest
Experimental	Solar System and Beyond Success Test (SSBST) Science Learning Anxiety Scale (SLAS) Astronomy Attitude Scale (AAS) Students' Motivation Scale for Science Learning (SMSS)	Teaching Supported by e-Mobile Application and Augmented Reality	Solar System and Beyond Success Test (SSBST) Science Learning Anxiety Scale (SLAS) Astronomy Attitude Scale (AAS) Students' Motivation Scale for Science Learning (SMSS)
Control	Solar System and Beyond Success Test (SSBST) Science Learning Anxiety Scale (SLAS) Astronomy Attitude Scale (AAS) Students' Motivation Scale for Science Learning (SMSS)	Teaching with the Methods Proposed by the Current Program	Solar System and Beyond Success Test (SSBST) Science Learning Anxiety Scale (SLAS) Astronomy Attitude Scale (AAS) Students' Motivation Scale for Science Learning (SMSS)

THE STUDY GROUP

The study taught with a total of 56 students studying in two separate 7th grades of a secondary school located in the Hatay/Antakya in the 2017-2018 academic year. The study groups were selected using the convinience sampling method as the groups were already formed in two branches in the school. Experimental groups of 29 students and control groups of 27 students were determined through random assignment.

DATA COLLECTION

As data collection tool, the "Solar System and Beyond Success Test" (SSBST), "Science Learning Anxiety Scale" (SLAS), "Astronomy Attitude Scale" (AAS) and "Students' Motivation Scale for Science Learning" (SMSS) was used in both groups before and after the application.

Solar System and Beyond Success Test (SSBST)

Solar System and Beyond Success Test consisted of initially 32 test questions, benefiting from the test books based on the unit's "Celestial Bodies", "Solar System" and "Spacecraft" subjects and 9 achievements in total. Before the pilot study to be conducted for the validity and reliability study of the test, the opinions of an expert instructor and two science teachers were taken to determine the suitability of the questions to the objectives, and a Turkish language expert to determine the suitability of the grammar rules. As a result of the feedback, question stem arrangements were made and grammatical errors were corrected. Then, to determine the validity and reliability of the test, a pilot application of the test was applied over 32 questions to 172 students attending 8th grade at two secondary schools in Hatay/Antakya, Turkey. Since the item discrimination index of 5 of the questions was below ,30 they were removed from the test and an achievement test of 27 questions was obtained. There were 11 questions on the subject of celestial bodies, 8 questions on the subject of the solar system, 8 questions on the subject of spacecraft in the SSBST. The results of SSBST item analysis were given in Table 2.

Table 2. SSBST Item Analysis Results

Item number	Item Difficulty Index	Item Standard Deviation	Item Discrimination Index	Item number	Item Difficulty Index	Item Standard Deviation	Item Discrimination Index
1	0,56	0,50	0,69	15	0,72	0,45	0,65
2	0,85	0,35	0,43	16	0,58	0,49	0,41
3	0,85	0,36	0,56	17	0,77	0,42	0,67
4	0,85	0,35	0,48	18	0,56	0,50	0,65
5	0,90	0,30	0,44	19	0,39	0,49	0,54
6	0,47	0,50	0,67	20	0,60	0,49	0,37
7	0,56	0,50	0,41	21	0,49	0,49	0,69
8	0,70	0,46	0,50	22	0,49	0,50	0,61
9	0,55	0,50	0,31	23	0,75	0,50	0,61
10	0,60	0,49	0,61	24	0,75	0,43	0,76
11	0,70	0,43	0,59	25	0,50	0,43	0,37
12	0,65	0,48	0,69	26	0,66	0,50	0,72
13	0,82	0,39	0,43	27	0,64	0,47	0,61
14	0,35	0,48	0,31				

As seen in Table 2, there are 14 easy questions with item difficulty index above 0.60, 11 medium difficulty questions with item difficulty index between 0.60 and 0.40 and 2 difficult questions with item difficulty index below 0.40 in test questions. KR20 reliability coefficient was calculated using the formula given below.

$$KR_{20} = \frac{K}{K-1}\left[1 - \frac{\sum pq}{S_x^2}\right]$$

K = Number of questions in the test
p = Item difficulty
q = 1- p

S_x^2 = Variance of the test (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2010).

KR-20 reliability coefficient of SSBST, calculated according to the above formula, was found to be 0.81. According to the data obtained, the final version consists of 27 questions, suitable for the class level, is a very well discriminating (0.54), easy (0.65) and reliable test. In addition, the researcher determined that the test was also valid by preparing a table of indicators to check the content validity after the questions. In addition, the researcher determined that the test was also valid by preparing a table of specification to check the content validity after the questions.

Science Learning Anxiety Scale (SLAS)

The "Science Learning Anxiety Scale" (SPSAS) used in the study was developed by Yıldırım (2015) to determine the anxiety of 5, 6, 7 and 8th grade students towards the science course. First of all, the draft scale with 32 items and 5-point Likert type was applied to 844 students after student interviews and expert opinions. First of all, the interface as a draft with 32 items and 5-point Likert type was applied to 844 students after student interviews and expert opinions. When the analysis process was completed, the 19-item scale, which was finalized, was gathered under three factors: teaching and content anxiety, student anxiety, and lesson anxiety. However, in this study, it is aimed to determine the anxiety of the students who participated in the application against their general science learning, rather than examining them in factorial dimensions. Cronbach's alpha reliability coefficient of the scale was calculated as 0.85 and it was determined that it is a reliable scale (Yıldırım, 2015).

Astronomy Attitude Scale (AAS)

To determine the students' attitudes about Astronomy, which is the subject of the study, the "Astronomy Attitude Scale" (ASST), which was finalized by Zeilik, Schau and Mattern (1999) was used. The scale was originally developed in two parts consisting of 34 items. Of these 34 items, 22 were for astronomy, and 12 were for determining their attitudes towards science. The initial form of the scale was developed as a 5-point Likert type, but in 1995 the scale was used as a 7-point Likert type (Zeilik, Schau, Mattern, Hall, Teague & Bisard, 1997; Zeilik, Schau & Mattern, 1999). The Cronbach alpha reliability coefficient of the scale used in this study was calculated as for the pre-test 0.86 and 0.92 for the post-test (Zeilik et.al.,1997). The adaptation study of the 5-point Likert type of the scale into Turkish was done by Bilici, Armağan, Çakır and Yürük (2012). In this study, 22 items of the scale developed for Astronomy by Zeilik et al. (1999) were used. Translation of the scale was made by experts in the field. Five students were interviewed to determine the comprehensibility of the items. The necessary arrangements were made and applied to the working group consisting of 255 people. As a result of the analysis, 7 items were removed from the scale and the "Astronomy Attitude Scale" with 15 items was created. The Cronbach alpha reliability coefficient of the scale was found to be 80 and it was determined to be a reliable scale.

Students' Motivation Scale for Science Learning (SMSS)

In this study, "Students 'Motivation Scale for Science Learning" (SMSS), developed by Tuan, Chin and Shieh (2005) and adapted into Turkish by Yılmaz and Çavaş (2007), was used in order to measure students' motivation towards science lessons. The 5-point Likert type scale initially contains 35 items. In order to adapt the scale to Turkish, science educators, foreign language experts and assessment and evaluation experts were consulted to ensure language validity. It was applied to a total of 659 students studying in 6 different schools' 6th, 7th, and 8th the grade, For scale validity and reliability studies, and as a result of the statistical analysis of the scale, 2 items were removed from the scale and the 33-item scale was finalized. The scale consists of six factors: the value of learning science, self-efficacy, active learning strategies, encouragement in the learning environment, performance goal, and achievement goal. However, this study did not examine the factorial dimension, it was aimed to determine the motivation of the students who participated in the application only towards science learning. The reliability of the scale was calculated by two methods: Equivalent Half (test halving) and Cronbach Alpha internal consistency. The reliability coefficient obtained by test halving was 0.89, Cronbach Alpha reliability coefficient was 0.87, and it was determined to be a reliable scale.

IMPLEMENTATION

INSTRUCTIONAL PROCESS USED IN THE RESEARCH

The implementation was carried out during a 5-week process, including 16 lesson hours of the delivery of the methods and four of the data collection. While a learning environment supported by augmented reality and mobile applications was used in one of the groups (in the experimental group), in the other (in the control group) a learning environment suitable for the methods suggested by the current curriculum was used. The lessons were conducted by the researcher in the experimental and control groups. Some of the materials were developed by the researcher, others were downloaded from the "play store" and "app store" programs as mobile applications.

Pre-tests were administered to the groups three months before the application started, and post-tests were administered immediately after the course delivery. As pre-test and post-test, the "Solar System and Beyond Success Test" (SSBST), "Science Learning Anxiety Scale" (SLAS), "Astronomy Attitude Scale" (AAS) and "Students' Motivation Scale for Science Learning" (SMSS) has been applied.

AUGMENTED REALITY AND MOBILE APPLICATION SUPPORTED INSTRUCTIONAL PROCESS

At the beginning of the implementation, the planning and design phase of the teaching process was proposed. Later, in line with the acquisitions, content selection and preparation of learning-teaching activities were started. In addition, a Space booklet was prepared by the researcher based on the general objectives and content in the Science course curriculum and the experimental group was taught according to active learning, technology-centered and internet interactive learning methods supported by mobile and augmented reality implementations. There are around 240 mobile application play stores in various languages related to the sky view and the solar system, which is the subject of research. 24 of all applications were VR (virtual reality), 9 of them were AR applications, and the remaining applications were 3D applications. However, only 10 of the 240 applications were in Turkish. All these mobile applications and their contents were analyzed by the researcher and the applications closest to the curriculum were used in the teaching process.

Before the implementation, groups of 4 students were formed and a tablet was given to each group. The students were requested to install "Sky View, "3D Solar System", "Solar System VR", "Hp Reveal" and "AR Science Cards" mobile applications from the playstore on the tablets and information was given about these programs. In addition, the Space booklet prepared by the researcher was distributed to the students.

Researchers began to "celestial bodies", the first subject of the unit, by "What do you observe when you look at the sky in a cloudless sky?" question. After receiving student answers, the students were taken to the garden of the school with tablets distributed to the groups and they were requested to observe the sky. Later, they were asked to watch the sky with the "Sky view free" application installed on their tablet (Figure 2). With the Sky viev free mobile application, which is a 3D software that shows the orbits of stars, planets and other celestial bodies based on the positions of the users, where they are at what time and where they will be found, students focus on the concepts of star, planet, constellation, space, universe and light years. They were asked whether they could see the celestial bodies belonging to them on tablet computers. During the solar observations were mentioned to things that need attention and Biruni's Works. In addition, they were requested to make the same observations at night and to note their observations. The students were given the opportunity to discuss the observation process, were requested to write down the celestial bodies they saw in the sky and their names, and opinions about the formation of the universe were discussed. As a result of all these observations and the research and questioning process, the differences between stars and planets were expressed by the students and they were requested to do the relevant activity in the space booklet.

Figure 2. Experimental group's sky observation with Sky View mobile application

The second subject of the unit, "Solar system", was entered by asking questions about the Sun and the planets in the Solar system, and then the students were requested to use the mobile application called 3D Solar System, which is a free mobile software that shows the planets and their movements in the universe in three dimensions. As seen in Figure 3, the students observed the planets and their properties with the mobile application called 3D Solar System. The researcher stated that the properties of the Sun and the planets in the Solar system are located in the left part of the 3D Solar System mobile application, requested them to carefully follow these features and answered the questions from the students as a result of the observations of the students

Figure 3. Experimental group's observation with 3D Solar System mobile application

In the next lesson, AR science cards with Turkish augmented reality application and software created by adding 3D images and sounds were distributed to the students. (Figure 4). Then, by using the Hp Reveal computer program, which enables the users to display a photo they have selected to the camera and play sound, video and animations, the relevant ones from the AG cards developed by the researcher were distributed to the students and the lessons were continued with these video-supported cards (Figure 5).

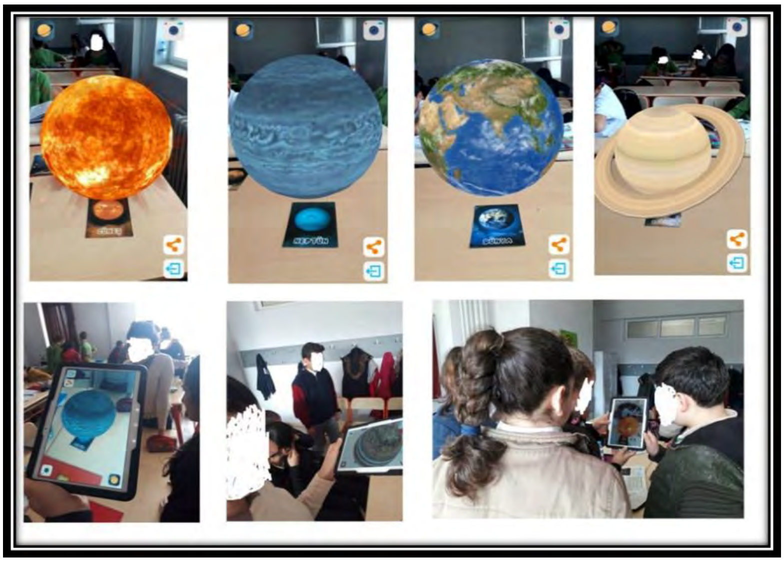

Figure 4. Experimental group's investigation of the Solar System and planets with AR Science cards

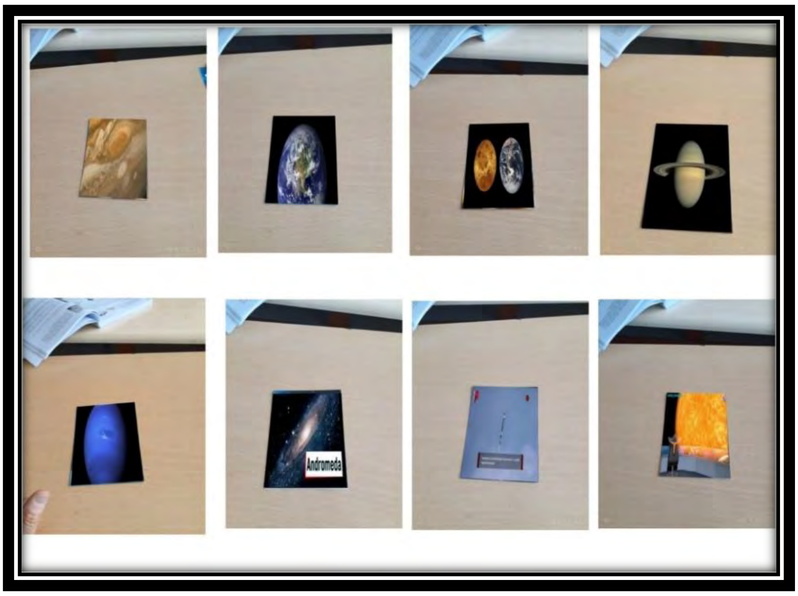

Figure 5. Experimental group's investigation of the Solar System with AG cards developed with Hp Reveal

As a result of their observations, the students expressed what they learned about the solar system and the planets, what they did that day, what attracted their attention the most, what they liked least and where they had the most difficulties.

Startinged with the question of "What is telescope good for?" in the of "spacecraft" subject which is the last subject of the unit. After discussing the students' answers, the AR cards prepared for the development of the telescope and space research were distributed to the students, and the students were requested to note their observations. The notes taken by the students were discussed and interpreted in the classroom environment. Then, the students were asked about the astronomer, astronaut, astrology, astronomy concepts they heard in daily life and their definitions and their answers were evaluated. Later, the students were requested to imagine themselves as an astronaut and write down their dreams. In the following process, students were given a virtual space tour with AR glasses distributed (Figure 6).

Figure 6. Experimental group students' investigation of the solar system with Solar System Vr (virtual reality)

Finally, AR cards related to space pollution were distributed to students and they were asked to read the card with tablets, after watching the video here carefully, it was discussed about the studies to be done to reduce space pollution. A general evaluation was made by the researcher at the end of the unit, and then the 16-hour implementation process was ended.

IMPLEMENTATION OF THE METHODS SUGGESTED BY THE CURRENT CURRICULUM

In the control group, activities and implementations related to the "Solar System and Beyond" unit in the textbook were made in line with the annual plan prepared according to the current science curriculum program. The researchers carried out various activities by using many techniques such as lecture, question-answer method and brainstorming techniques to increase students' interest in the lesson. In addition, various videos, images and animations related to the subject were watched from EBA.

The course started with some preparatory questions on the subject of "celestial bodies", which is the first subject of the unit, and discussed over the questions in the textbook. During the solar observations were mentioned to things that need attention and Biruni's Works. Students' views on the concepts of universe and space and the formation of the universe were taken. The differences between stars, constellations, light years, and planets are given to students based on their research and inquiries. At the end of the subject, "Let's observe" activity and subject tests were done. The second subject of the unit was introduced by asking some questions about the Sun and the Solar system, and then their definitions were made and the properties of the planets in the solar system were expressed as given in the textbook. Then, the "Let's make a model" activity was made to the students according to the instruction in the textbook (Figure 7).

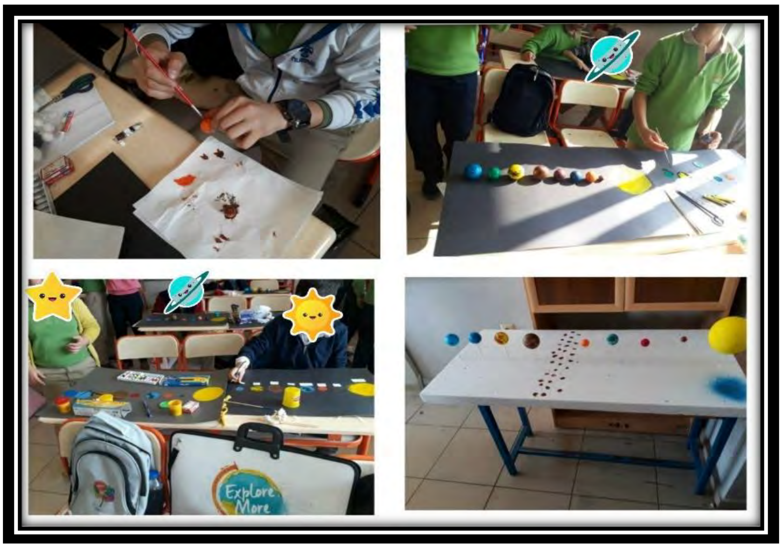

Figure 7. The control group students' "Let's Make a Model" activity studies

It is pointed out that the materials used in the modeling process should be suitable for the size order of the planets. After making the model, the documentary about the properties of the solar system and the planets was watched. Then, the definition of Galaxy was given and end-of-topic activity and topic tests were made. The subject of "spacecraft", which is the last subject of the unit, has been started with a few general questions about the subject. After the answers to these questions were discussed in the classroom, the necessary information was provided by the researcher. Later, the students were requested to do research on space technologies. After the students did their research, they presented the results of the research in the classroom. Then, the astronomer, astronaut, astrology, astronomy concepts and their definitions were asked to the students and their answers were evaluated. After this evaluation, the students were requested to imagine themselves as an astronaut and write a day in space in their notebooks, and the texts written by the students were read aloud in the classroom and necessary feedbacks were made.

Finally, students' ideas about reducing space pollution were taken and discussed. Then, the lesson was ended by having activities and tests at the end of the subject.

DATA ANALYSIS

Statistical analysis of the data obtained within the scope of the research was made using the SPSS package program. In order to decide which tests to use in the analysis phase of the data, normality test was performed and independent t-test was applied for the data showing normal distribution. In addition, in the analyzes, Cohen's d effect size was calculated for the independent t-tests of the posttests that had a significant difference between the groups in order to determine the degree to which the independent variable affected the dependent variable.

In the research, it is necessary to examine the normality of the tests in order to decide which test will be used in the analysis of the data obtained from the pre-tests of the SSBST, SLAS, AAS, SMSS and post-tests of the same tools applied to the study group. In the study, Shapiro-Wilk test results were examined because the sample size was less than 29 in both the experimental and control groups (Kalaycı, 2016). The SSBST, SLAS, AAS, SMSS pre-test and post-test normality test results are given in Table 3.

Table 3. SSBST, SLAS, AAS, SMSS pre-test and post-test normality test results

Group	Tests		Statistics	df	F	skewness	kurtosis
Experimental	Pre-test	SSBST	,954	29	,231	-,211	,237
		SLAS	,974	29	,659	-1,394	2,610
		AAS	,954	29	,230	-,788	1,964
		SMSS	,878	29	,003*	,132	-,663
	Post-test	SSBST	,926	29	,014*	-,806	,087
		SLAS	,945	29	,138	,426	-,891
		AAS	,926	29	,044*	-,935	1,964
		SMSS	,948	29	,163	-,261	,042
Control	Pre-test	SSBST	,956	27	,295	,356	1,232
		SLAS	,972	27	,652	-,938	,791
		AAS	,969	27	,572	-,187	-,439
		SMSS	,924	27	,050	,038	-,685
	Post-test	SSBST	,963	27	,424	-,522	-,030
		SLAS	,973	27	,675	-,048	-1,120
		AAS	,932	27	,077	,461	-,768
		SMSS	,956	27	,305	,272	-,342

When the Shapiro-Wilk test results of the Experiment Group (EG) and Control Group (CG) in Table 3 are examined, while EG's SMSS pre-test, SSBST post-test and AAS post-test data do not show normal distribution (p<0,05), it is seen that EG and CG's other tests show normal distribution (p>0,05).
However, since the kurtosis and skewness values of the tests with p<0.05 were between -3 and +3, it was decided that they were suitable for normal distribution (Kalaycı, 2016). Therefore, independent t-test was used to compare experimental and control groups in the study.

FINDINGS

An independent t-test was applied to analyze whether there is a significant difference between the "Solar System and Beyond" unit academic achievement pre-test scores of the EG students, for whom the courses were taught supported by augmented reality and mobile implementations were planned and the CG students for whom the courses were planned using the methods suggested by the current curriculum program. Independent t-test results were given in table 4.

Table 4. Independent t-Test Analysis Results of SSBST Pre-Test Scores

Groups	n	$\bar{X}$	SD	Df	t	p
Experimental group	29	52,83	17,869	54	1,088	.282
Control Group	27	47,85	16,247			

The maximum score for SSBST is 108.

When the data in Table 4 were examined, it is seen that there is no statistically significant difference between the SSBST of EG and CG (t=1.088; p>0.05). According to these findings, it can be said that the success levels of the students in EG and CG were similar in the "Solar System and Beyond" unit before starting the implementation.
Independent t-test was applied to find out whether there was a statistically significant difference between the mean SSBST post-test scores of the EG students and the CG students. Analysis results were given in Table 5.

Table 5. Independent t-Test Analysis Results for SSBST Post-Test Scores

Groups	n	$\bar{X}$	SD	Df	t	p	Cohen's *d*
Experimental group	29	93,24	9,628	54	8,422	.000	2,227
Control Group	27	59,26	19,312				

The maximum score for SSBST is 108.

Looking at the data in Table 5, it is seen that there is a statistically significant difference in favor of EG between the SSBST posttests of EG and CG (t=8.422; p<0.05). The cohen's d size, which shows the effect size of the experimental group practices on success, shows that the effect is very large (Cohen's *d*=2,227). According to these findings, it was seen that the achievement levels of the students in EG were higher than the students in CG. It is thought that the concretization of 7th grade Astronomy subjects and teaching with AR and mobile applications were effective in increasing academic achievement.

Independent t-test was applied to understand whether there is a statistically significant difference between the mean scores of the "Science Learning Anxiety Scale" (SLAS) pre-test scores of the students in EG and CG. Analysis results were given in Table 6.

Table 6. Independent t-Test Analysis Result of SLAS Pre-Test Scores

Groups	n	$\bar{X}$	SD	df	t	p
Experimental group	29	37,00	9,986	54	,347	.730
Control Group	27	36,11	9,108			

The maximum score for SLAS is 95.

When looking at the data in Table 6, it is seen that there is no statistically significant difference between EG and CG pre-tests (t=0.347; p>0.05). According to these findings, it can be said that the science learning anxiety levels of the students in EG and CG were similar before starting the implementation.

Independent t-test was applied to determine whether there was a statistically significant difference between the mean SLAS post-test scores of the students in EG and CG. Analysis results were given in Table 7.

Table 7. Independent t-Test Analysis Result of SLAS Post-Test Scores

Groups	N	$\bar{X}$	SD	df	t	p
Experimental group	29	48,14	15,524	54	-0,115	.909
Control group	27	48,56	11,164			

The maximum score for SLAS is 95.

When the data in Table 7 were examined, it is seen that there is no statistically significant difference between the SLAS posttests of EG and CG (t=0.115; p>0.05). According to these findings, it is seen that there is no difference, and it can be said that the science learning anxiety levels were similar after the implementation. However, when the SLAS post-test scores of the groups were examined, it was seen that their anxiety levels increased compared to their pre-test scores. By causing an increase in anxiety and tension levels; the thought of being unsuccessful at the end of the academic process, students' awareness of the implementation, and their unfamiliarity with the process can be shown.

Independent sample t-test was applied to determine whether there is a statistically significant difference between the mean scores of the "Astronomy Attitude Scale" (AAS) pre-test scores of the students in EG and CG. Analysis results were given in Table 8.

Table 8. Independent t-Test Analysis Result of AAS Pre-Test Scores

Groups	n	$\bar{X}$	SD	df	t	p
Experimental group	29	49,28	6,948	54	-,117	.907
Control Group	27	49,48	6,123			

The maximum score for AAS is 75.

When looking at the data in Table 8, it is seen that there is no statistically significant difference between the pre-tests of EG and CG of DG and CG (t=-0.117; p>0.05). According to these findings, it can be said that students in EG and CG have similar attitudes towards astronomy before starting the implementation. This situation can be explained by the similarities of the students' past experiences on the subject.

Independent t-test was applied to understand whether there is a statistically significant difference between the mean scores of AAS post-test of the students in EG and CG. Analysis results were given in Table 9.

Table 9. Independent t-Test Analysis Result of AAS Post-Test Scores

Groups	n	$\overline{X}$	SD	df	t	p	Cohen's *d*
Experimental group	29	42,38	8,170	54	-2,736	.008	0,738
Control Group	27	47,41	5,116				

The maximum score for AAS is 75.

Considering the data in Table 9, it is seen that there is a statistically significant difference between the AAS post-tests of the experimental and control groups ($t=-2,736$; $p<0.05$). According to these findings, it was observed that there was a difference in the attitude towards Astronomy levels in favor of CG students after the implementation was made. When Cohen's d effect size value is examined, it is seen that experimental group practices have a negative effect on students' attitudes towards Astronomy (Cohen's d=0,738). However, when the AAS pre-test and post-test arithmetic averages of both groups were examined (Table 8, Table 9), it was seen that the post-test scores decreased. This situation suggests that the students noticed that they were involved in an implementation and that awareness caused them to develop a negative attitude towards the subject.

To determine whether there is a statistically significant difference between the averages of the "Students' Motivation Scale for Science Learning" (SMSS) pre-test scores of the students in EG and CG, independent sample t-test was applied and the analysis results were given in Table 10.

Table 10. Independent t-Test Analysis Results of the SMSS Pre-Test Scores

Groups	n	$\overline{X}$	SD	df	t	p
Experimental group	29	121,76	16,858	54	,224	.824
Control Group	27	120,85	13,020			

The maximum score for SMSS is 165.

When looking at the data in Table 10, it is seen that there is no statistically significant difference between the experimental and control groups in the SMSS pre-tests ($t=0.224$; $p>0.05$). According to these findings, it can be said that students in EG and CG have similar levels of motivation for science teaching before they start to practice.

To determine whether there is a statistically significant difference between the mean scores of the SMSS post-test of the students in DG and CG, independent sample t-test was applied and the analysis results were given in Table 11.

Table 11. Independent t-Test Analysis Result of the SMSS Post-Test Scores

Groups	n	$\overline{X}$	SD	df	t	p
Experimental group	29	127,21	17,145	54	1,079	.285
Control Group	27	122,81	12,827			

The maximum score for SMSS is 165.

When looking at the data in Table 11, it is seen that there is no statistically significant difference between EG and CG's post-tests in SMSS ($t=1.079$; $p>0.05$). According to these findings, it can be said that the motivation levels of students in EG and CG towards science teaching were similar after the implementation. The fact that the methods proposed by the current program applied to the control group were also suitable for active learning, and the teaching of the lesson with these methods, the students' willingness to listen to science lesson, to learn science, to quench their curiosity, and to discuss science issues, can be shown as a reason that there is no difference between the groups.

DISCUSSION AND CONCLUSION

In this study, the effect of augmented reality and mobile application supported instruction on the students' academic achievement, attitudes towards astronomy and their anxiety and motivation towards learning science in the Solar System and Beyond/Earth and Universe unit of the seventh grade Science lesson were examined. Before the implementation, it was determined that the groups showed similar characteristics in terms of their academic achievement, attitude towards astronomy and anxiety and motivation towards learning science. At the end of the instructional process, a significant difference in favor of the experimental

group was found between the groups in terms of academic achievement in the Solar System and Beyond/Earth and Universe unit. At the secondary school level, "Solar System and Beyond" is one of the units that contain abundant abstract concepts that are difficult to explain by teachers. Mobile applications and AR technology constitute a concrete life for learning and it is thought to positively affect the success levels of students. There are many studies in the literature that show that Mobile and AR applications increase course success (Vilkoniene, 2009; Sin & Zaman, 2014; Sırakaya, 2015; Demirel, 2017, Eroğlu, 2018; Kaufmann & Schmalstieg, 2002; Rashvand & Hsiao, 2015; Ibáñez, Di Serio, Villarán & Kloos, 2014; Chiang, Yang & Hwang, 2014; Ersoy, Duman & Öncü, 2016; Korucu, Gençtürk & Sezer, 2016; Başal, 2019; Cai, Chiang, & Wang, 2013; Özarslan, 2013; Abdüsselam & Karal, 2012; İbili, 2013; Çakır, Solak, & Tan, 2015; Sırakaya, 2015; Bicen & Bal, 2016; Gül, 2016; Şahin, 2017; Buluş-Kırıkkaya & Şentürk, 2018; Çankaya & Girgin, 2018; Şentürk, 2018). In addition to these, there are also studies that do not comply with this study (Kayabaşı, 2016; Baysan & Uluyol, 2016; Erbaş, 2016; Baysan, 2015; Gün, 2014).
When the research process was completed, the results of SLAS, which were applied post-tests to the groups in order to determine whether augmented reality and mobile applications supported instruction affected students' anxiety on learning science, showed that this instruction did not have any effect on students' anxiety in learning science. However, it was observed that anxiety levels increased compared to pre-test scores. The thought of being unsuccessful at the end of the academic process, the realization of the implementation, and their unfamiliarity with the process can be shown, which causes an increase in anxiety and tension levels. When the related literature is analyzed, there are studies showing that similar practices give similar results, while there are studies showing that students reduce anxiety towards the lesson (Başal, 2019; İbili, 2013; Küçük, Yılmaz, & Göktaş, 2014).
The results of AAS applied to the groups at the end of the application to determine the effect of teaching supported by augmented reality and mobile applications on students' attitudes towards astronomy show that the methods proposed by the current program are more effective than teaching supported by augmented reality and mobile applications. However, when we look at the pre-test and post-test arithmetic averages of AAS applied to the groups from this study, it is seen that both the AAS scores of the groups decrease after the application. This situation suggests that the students noticed that they were involved in an application and that awareness caused them to develop a negative attitude towards the subject. When the related literature is examined, there are studies that do not match the results of the study and show that mobile and AR applications positively affect the attitude towards science (Kayabaşı, 2016; Cai, Chiang, & Wang, 2013; Akçayır, 2016; Şahin, 2017, Sırakaya & Sırakaya, 2018; Şentürk, 2018), no study has been found on how it affects attitude towards astronomy.
The results of the SMSS applied to the groups showed that the scores of experimental group had similar to the students' scores who taught by the current curriculum. This suggested that the methods proposed by the current curriculum applied to the control group were also effective for active learning, effective in listening to science lesson, in learning science, in eliminating curiosity, since they were willing to discuss science issues, it does not create any difference between the groups. When the relevant literature is examined, there are studies showing that similar practices affect motivation positively (Chiang, Yang, & Hwang, 2014; Ersoy, Duman & Öncü, 2016; Yıldırım, 2016; Çakır, Solak & Tan, 2015; Sırakaya, 2015; Erbaş, 2016; Onbaşılı , 2018; Sırakaya & Sırakaya, 2018; Şentürk, 2018).

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