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Investigation of the Effects of Augmented Reality Applications on the Astronomy Literacy Levels of Secondary School Students

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Abstract

In this study, it is aimed to determine the astronomy literacy levels of the seventh and eighth grade secondary school students and to investigate the effect of augmented reality [AR] applications on the astronomy literacy levels of the students. The research is a quantitative study and a quasi-experimental method was used. The study group consists of a total of 95 seventh and eighth grade students (n7th grade = 46 and n8th grade = 49) studying in a secondary school in the central district of Ankara in the spring semester of the 2021-2022 academic year. The students of the study group of the research were selected by using convenient sampling method. Two experiments and two control groups were used in the study. The data of the research were obtained with the astronomy literacy scale before and after the application. In practice, the lessons were taught within the framework of basic astronomy concepts, with augmented reality applications in the experimental groups, and with the activities suggested in the textbooks in line with the achievements specified in the curriculum in the control groups. As a result of the analysis of the data, it was noted that the students' astronomy literacy levels were low before the application. After the application, the astronomy literacy levels of the experimental group students were high; it was seen that the control group students reached the intermediate level. It was determined that augmented reality [AR] applications positively affected the astronomy literacy levels of the experimental group students.

Keywords: Astronomy literacy, augmented reality, middle school students.

Introduction

Since ancient times, human beings have been in a desire and curiosity to understand, discover, and know the sky. In particular, the necessity of human beings to lead a more comfortable and reliable life on earth has been one of the factors that led to this desire. Since ancient times, astronomy has been a subject of interest, curiosity and research for people of all age groups, and the importance of astronomy has gradually increased with the rapidly developing technology. Understanding astronomy subjects and concepts in the Science Curriculum is an important part of science literacy. One of the main objectives of the 2018 Science Curriculum is "to provide basic information about astronomy, biology, physics, chemistry, earth and environmental sciences, and science and engineering applications." (Ministry of National Education [MoNE], 2018). When the renewed curriculum is examined, there are astronomy units within the subject area of "Earth and Universe". These units start from the 3rd grade. Astronomy units within the scope of the subject area are seen as the first unit of each education level. In this context, the astronomy units given at the beginning of the education process allow students to learn the basic astronomy subjects and concepts more efficiently. According to a study conducted by the Scientific and Technological Research Council of Türkiye [TUBITAK] to measure the scientific literacy of individuals between the ages of 15-24, it has been determined that the subjects with the highest level of interest and curiosity are "internet" and "astronomy" [MoNE, 2010].

An efficient, effective and successful astronomy curriculum should aim at attitudes, values, interests, motivation, observations and practices towards astronomy as well as cognitive knowledge and skills. In this context, affective and behavioral gains should be included along with cognitive acquisitions related to astronomy at all levels of education. Whether individuals have cognitive, affective and behavioral gains in astronomy subjects and concepts can be evaluated with "astronomy literacy".

The concept of "astronomy literacy" is to have multidimensional skills about the cognitive dimension of the basic astronomy concepts of the individual, as well as the behavioral and affective dimensions. An astronomy literate individual; conceptual knowledge of basic astronomy issues in terms

of cognitive dimension; positive attitude, interest and motivation towards astronomy in terms of affective dimension; In terms of behavioral dimension, it should have observation, participation and action related to astronomy. Love et al. (2013) determined the astronomy literacy level of 990 adult individuals over the age of 18. These individuals were asked six true-false questions. 80% of the participants gave correct answers to 4 of the 6 questions asked. However; The questions "Astronomers found life on Mars" and "They can calculate the age of the universe" are among the two questions most frequently answered incorrectly by the participants.

In a study, it is emphasized that astronomy literacy is an important part of scientific literacy. The use of technology and its applications in teaching astronomy concepts and subjects plays a very important role in embodying abstract concepts, understanding difficult subjects, and gaining affective and behavioral goals. The main objectives of the use of technology in education are to be more active in the teaching process, to reach the achievements more effectively, to increase efficiency and to provide education services for large masses (Baysal, 2016). Considering the stated objectives, it is understood that the inclusion and use of technology in the teaching of Science concepts and subjects makes learning easier, and contributes to education with the effect of permanently effective and understanding-based learning (Çankaya, 2019).

Many studies have revealed that technology and its applications enrich teaching methods and strategies, students are actively in the learning process and contribute to making education more efficient by providing mutual interaction (Küçüksaraç & Sayımer, 2016). Especially in recent years, technology and its applications have been given more place in science education. One of the methods and techniques that is one of the less used materials in education but will make a strong contribution to education is augmented reality [AR] technology (Sarıca, 2019). AR applications are a technology that allows both real and virtual objects to be seen together in an environment where virtual objects and contents are included in real environment images without disconnecting them from the real world (İçten & Bal, 2017). Increasingly functional components, especially in mobile devices, have benefited in terms of augmented reality applications. Many augmented reality applications such as Sky View, Google Sky Map, Night Sky, Solar Walk, Star Walk, Sky Guide AR and Stellarium have been developed to enrich the use of mobile devices in the field of astronomy. These applications, through mobile devices, provide learning from real images of celestial bodies and offer the opportunity to take various recordings. These features provide an easy, permanent, productive and enjoyable learning environment for individuals from all age groups in learning astronomy. In addition, educational studies using AR technology, which is rapidly developing and taking its place in the teaching process, are increasing day by day. When the literature is examined; In a study conducted by Aktamış and Arıcı (2013), it was revealed that seventh grade students' astronomy success increased and their knowledge was not forgotten after the implementation of virtual reality applications in astronomy teaching. In another study, Tian et., al. (2014), in their study at the university, revealed that the AR applications that university students use while observing are more effective. In the study conducted by Say and Pan (2017), it was stated that there was a significant increase in the academic achievement and attitudes of the students who participated in the courses conducted with AR applications. The process of teaching astronomy concepts with augmented reality applications was carried out by Danaia, McKinnon, and Fitzgerald (2017) with students and teachers. At the end of the teaching process, it was determined that there were significant developments in students' perceptions about science. In the study conducted by Şahin and Yılmaz (2020), it was observed that the academic achievements of the students and their attitudes towards the

astronomy lesson changed positively in the teaching of astronomy with AR applications. In their study, Tanık Önal and Önal (2021) observed that the academic achievement and interest of the students increased at the end of the AR supported astronomy courses with gifted students. Considering the researches, individuals who receive astronomy education using AR environments; their success in astronomy has increased (Buluş Kırıkkaya and Şentürk, 2018; Şahin and Yılmaz, 2020; Tanik Önal and Önal, 2021), forgetting about astronomy concepts is less (Aktamış and Arıcı, 2013), their attitudes towards astronomy have improved (Say and Pan, 2017; Şahin and Yılmaz, 2020; Tanik Önal and Önal, 2021), observation abilities increased (Tian et al., 2014). When the literature is examined; It is seen that the studies conducted on astronomy are carried out on academic achievement, permanence of learning or attitudes, interest and motivation towards astronomy. However, there has not been any research on students' "astronomy literacy" levels. In this context, it is thought that examining students' astronomy literacy levels in this study and improving their AR applications and astronomy literacy levels will fill the gap in the literature.

In this study, it is aimed to determine the astronomy literacy levels of secondary school seventh and eighth grade students and to investigate the effect of augmented reality [AR] applications on students' astronomy literacy levels. In line with the stated main purpose, the problem statement of the research is as follows: "Does the augmented reality applications have an effect on the astronomy literacy levels of secondary school students?" In line with the stated main purpose, the problem statement of the research is: "Does augmented reality applications have an effect on the astronomy literacy levels of secondary school students?" can be expressed as. Based on the problem statement of the research, the sub-problems determined are listed below:

1. Is there a significant difference between the pretest and posttest averages of astronomy literacy levels of 7th grade experimental group students?

2. Is there a significant difference between the pretest and posttest averages of astronomy literacy levels of 7th grade control group students?

3. Is there a significant difference between the astronomy literacy level pretest averages of 7th grade experimental and control group students?

4. Is there a significant difference between the astronomy literacy level posttest averages of 7th grade experimental and control group students?

5. Is there a significant difference between the pretest and posttest averages of the astronomy literacy level of the 8th grade experimental group students?

6. Is there a significant difference between the pretest and posttest averages of astronomy literacy levels of 6th and 8th grade control group students?

7. Is there a significant difference between the pretest averages of astronomy literacy levels of 7th and 8th grade experimental and control group students?

8. Is there a significant difference between the astronomy literacy level posttest averages of 8th grade experimental and control group students?

Method

In this section, information about the model of the research, the study group of the research, the collection of data, the data collection process and the analysis of the data are given.

Model of the Research

A quasi-experimental design with a pretest-posttest control group was used in the research. (Büyüköztürk, 2011). In this study, the independent variable whose effect on the experimental groups was examined is augmented reality applications. In the control groups, these are the practices recommended in the Science course curriculum. The dependent variable in the groups is astronomy literacy level. In the study, the astronomy literacy levels of the students participating in the study were monitored before and after the learning process, on the basis of astronomy concepts. The main feature of experimental research is that independent variables can be controlled (McMillan, 2000, p. 207). The experimental design model used in the research is shown in Table 1.

Table 1. *Quasi-experimental design model of the study with pretest-posttest control group*

Groups	Pretest	Method	Posttest
E1	Pr1	X1	Po1
C1	Pr1	X2	Po1
E2	Pr2	X1	Po2
C2	Pr2	X2	Po2

E1: Experimental group 7th grade

C1: Control group 7th Grade

E2: Experimental group 8th grade

C2: Control group 8th Grade

Pr1: 7th grade pretest measurements

Pr2: 8th grade pretest measurements

X1: The learning method whose effect was observed on the experimental groups

X2: The learning method whose effect was observed on the control groups

Po1: 7th grade posttest measurements

Po2: 8th grade posttest measurements When Table 1 is examined, the independent variable that has an effect on the learning outcomes (astronomy literacy levels) of the participants is the practices in the learning process based on astronomy concepts.

Studying Group

In this study, the study group was selected according to the convenience sampling method using non-probability sampling method. In this method, participants are selected from among individuals who are easily accessible to the researcher, volunteer and suitable for the research (Gravetter & Forzano, 2012). The study group consists of seventh and eighth grade students (n7th grade = 46 and n8th grade = 49) studying at a public secondary school in the central district of Ankara in the spring term of the 2021-2022 academic year. During the study, a total of four different classes, two experimental and two control groups, were studied. The descriptive statistics results for the participants in the study group in Table 2.

Table 2. *Descriptive statistics results for the participants in the study group*

Grade Level	Group	Gender				Total	
		Girl		Boy			
		n	%	n	%	n	%
7th Grade	Experimental	13	59	9	41	22	23.15
	Control	12	50	12	50	24	25.25
8th Grade	Experimental	12	46.1	14	53.9	26	27.35
	Control	12	52.2	11	47.8	23	24.25
	Total	49	51.6	46	58.4	95	100

According to Table 2, 51.6% of the participants are 7th grade students and 58.4% are 8th grade students.

Data Collection Tools

The data obtained in this study were collected with the "Astronomy Literacy Scale" developed by the researcher.

Astronomy Literacy Scale

The "Astronomy Literacy Scale" developed by the researcher was used to measure the students' astronomy literacy levels (Benli Özdemir, 2022). The scale is a five-point Likert type, consists of 16 judgments and has a 3-factor structure. The scale includes the affective dimension for astronomy, the behavioral dimension for astronomy, and the cognitive dimension for astronomy. The 16 items in the scale are numbered from 1 point to 5 points, from the lowest to the highest level of students' astronomy literacy levels. While the highest score that can be obtained from the scale is 80; The lowest score is 16. In the scale, 1-15 point ranges are considered very low, 16-31 point ranges are considered low, 32-47 point ranges are considered medium, 48-63 points are considered high, and 64-80 point ranges are considered very high. A reliability study was conducted for the astronomy literacy scale developed by the researcher (Benli Özdemir, 2022). The scale was applied to 213 students different from the study group. According to the analysis obtained, the coefficients of internal consistency and sub-factors were determined. The reliability coefficient was found as α =.87. Since this value is above α = .70, the measurement tool has sufficient reliability to collect data (Büyüköztürk, 2011). When the reliability levels of the sub-factors of the scale were analyzed in the study, it was found that α =.77, α =.82 and α =.81. The reliability levels of the sub-factors were also found to be reliable (Alpar, 2003).

Implementation Process

This research was carried out with a total of 95 students studying in four different branches in the seventh and eighth grades in the spring term of the 2021-2022 academic year in a state secondary school in the central district of Ankara. Attention was paid to the volunteering principle of the students in the participant group of the study. In order to increase the reliability of the research, it was carried out with four classes, two experimental groups and two control groups, studying in the 7th and 8th grades. Information about the learning process in practice is given in Table 3.

Table 3. *Learning process carried out in practice*

Grade Level	Studying Groups	Pretest	Application process	Application time	Postest
7th grade	Experimental group 1	Astronomy Literacy Scale	Augmented Reality Applications	16 Lesson Hours	Astronomy Literacy Scale
7th grade	Control Group 1	Astronomy Literacy Scale	Recommended Practices in Textbooks	16 Lesson Hours	Astronomy Literacy Scale
8th grade	Experimental group 2	Astronomy Literacy Scale	Augmented Reality Applications	16 Lesson Hours	Astronomy Literacy Scale
8th grade	Control Group 2	Astronomy Literacy Scale	Recommended Practices in Textbooks	16 Lesson Hours	Astronomy Literacy Scale

Before the application, the "Astronomy literacy scale" was applied as a pre-test in order to measure the astronomy literacy levels of the students in the study group. Then, the application on the basis of astronomy concepts was completed by the researcher in the experimental and control groups in a total of 16 lesson hours as indicated in the table. With the experimental group students, astronomy subjects and concepts were taught with AR applications (Sky Guide AR, SkyView Lite, Night Sky 8, Sky Map, Star Walk 2, Solar Walk 2, Stellarium Plus, etc.). The activities carried out in the experimental and control groups during the application process are given in Table 4.

Table 4. *Activities carried out in the experimental and control groups during the implementation process*

Week	Experimental Group Activities	Control Group Activities
1st week (4 Lesson Hours)	"I am observing the sky using an augmented reality application" activity (2 Hours) "I am making virtual reality glasses" activity (2 hours)	"I am observing the sky with the naked eye" activity (2 hours) "I'm making a simple telescope" activity (2 Hours)
2nd week (4 Lesson Hours)	"I travel to space with the planetarium" activity (2 hours) "I see the sun using an augmented reality application" activity (2 Hours)	"I am building my dream spacecraft" activity (2 Hours) "I make a solar model using simple materials" activity (2 Hours)
3th week (4 Lesson Hours)	"I see the world using an augmented reality app" activity (2 Hours) "I see the Moon using an augmented reality app" activity (2 Hours)	"I make a world model using simple materials" activity (2 Hours) "I make a Moon model using simple materials" activity (2 Hours)
4th week (4 Lesson Hours)	"I see constellations using augmented reality app" activity (1 Hour) "Unique journey to the sky with Space 4D+ Augmented Reality Card Set" activity (2 Hours) Implementation of the posttest (1 hour)	"I make constellations with colorful pencils" activity (1 Hour) Preparation and playing activity of the game "sky in our classroom" (2 Hours) Implementation of the posttest (1 hour)

Photograph 1. *Photos of the application process*

Some photos of the augmented reality application and "I am observing the sky" activities carried out in the 7th and 8th grade experimental groups during the application process are given below.

Analysis of Data

The data of the "astronomy literacy scale", which is used to measure the astronomy literacy levels of the students before and after the application, were analyzed with the SPSS statistical package program. Appropriate statistical methods were determined for each sub-problem related to quantitative data. Then, dependent groups t-test was used for intragroup comparisons, and independent groups t-test analysis was performed for intergroup (experiment-control) comparisons.

Ethical Permits of Research

In this study, all the rules specified to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were complied with. None of the actions specified under the heading "Actions Contrary to Scientific Research and Publication Ethics", which is the second part of the directive, have been taken.

Ethics Committee Permission Information:

Ethics, principles and rules were followed at all stages of this research.

Findings

In the study, determining the astronomy literacy levels of secondary school seventh and eighth grade students and the effect of augmented reality applications on students' astronomy literacy levels were investigated.

Findings and Comments on the Data of the 7th Grade Experimental and Control Group Students

The findings and comments regarding the astronomy literacy levels of the students in the 7th grade study group are given below.

Findings and Comments on the Astronomy Literacy Levels Pretest and Posttest Scores of the 7th Grade Experimental Group Students

Is there a significant difference between the pretest and posttest scores of the 7th grade experimental group students' astronomy literacy levels? The results of the t-test analysis for the dependent samples related to the sub-problem are given in Table 5.

Table 5. *Dependent samples t-test results of pretest-posttest mean scores of 7th grade experimental group students' astronomy literacy levels*

	n	$\overline{X}$	ss	df	t	p	η^2
Pretest	22	41.59	8.47	21	-13.73	.00	.89
Posttest	22	67.00	4.40				

When Table 5 is examined, it is seen that there is a significant difference when the pretest-posttest mean scores of the 7th grade experimental group students' astronomy literacy levels are examined (t_{21} = - 13,73, p = 0.00 < 0.05). The posttest mean score of the experimental group students ($\overline{X}$ = 67,00), was higher than the pretest mean score ($\overline{X}$ = 41,59). It has been seen that augmented reality applications make a positive contribution to students' astronomy literacy levels. It is possible to say that the effect size of augmented reality applications on the average score of astronomy literacy levels is large (η^2 = .89).

Findings and Comments on the Astronomy Literacy Levels Pretest and Posttest Scores of the 7th Grade Control Group Students

Is there a significant difference between the pretest and posttest scores of the 7th grade control group students' astronomy literacy levels? the t-test analysis results for the dependent samples related to the sub-problem are given in Table 6.

Table 6. *Dependent samples t-test results of pretest-posttest mean scores of 7th grade control group students' astronomy literacy levels*

	n	$\overline{X}$	ss	df		p
Pretest	24	39.17	7.28	23	t	.03
Posttest	24	41.96	4.71		-2.22	

When Table 6 is examined, it is seen that there is a significant difference when the pretest-posttest mean scores of the 7th grade control group students' astronomy literacy levels are examined (t_{24} = -2,22, p = 0.03 < 0.05). The mean score of the control group students after the application ($\overline{X}$ = 41.96) was close to the pre-application scores ($\overline{X}$ = 39.17).

Findings and Comments on Astronomy Literacy Levels Pretest Scores of 7th Grade Experimental and Control Group Students

Is there a significant difference between the astronomy literacy levels and pretest scores of the 7th grade experimental and control group students? the t-test analysis results for the independent samples related to the sub-problem are given in Table 7.

Table 7. *Independent samples t-test results of pretest mean scores of 7th grade experimental and control groups students' astronomy literacy levels*

Group	n	$\overline{X}$	ss	df	t	p
Experimental	22	41.59	8.47	44	1.04	.30
Control	24	39.17	7.28			

When Table 7 is examined, there is no significant difference between the average scores of the 7th grade students' pre-application astronomy literacy levels (t_{44} = 1,04, p = 0.30 > 0.05). The mean score of the experimental group students ($\overline{X}$ = 41.59) and the mean score of the control group students ($\overline{X}$ = 39.17) are close.

Findings and Comments on Astronomy Literacy Levels Posttest Scores of 7th Grade Experimental and Control Group Students

Is there a significant difference between the astronomy literacy levels and pretest scores of the 7th grade experimental and control group students? the t-test analysis results for independent samples related to the sub-problem are given in Table 8.

Table 8. *Independent samples t-test results of posttest average scores of 7th grade experimental and control groups students' astronomy literacy levels*

Group	n	$\overline{X}$	ss	df	t	p	η^2
Experimental	22	67.00	4.40	44	18.56	.00	.88
Control	24	41.96	4.71				

When Table 8 is examined, it is seen that there is a significant difference when the posttest mean scores of the 7th grade experimental and control group students' astronomy literacy levels are examined (t_{44} = 18,56, p = 0.00 < 0.05). The posttest average score ($\overline{X}$ = 67.00) of the students studying with augmented reality applications is higher than the posttest average score ($\overline{X}$ = 41.96) of the students studying with the applications suggested in the textbooks. When the effect value of augmented reality applications is examined, it is seen that the eta square value (η^2 = .88) has a large effect value. Eta square (η^2) value shows that this difference is not accidental (Cohen, 1988: 44).

Findings and Comments on the Data of the 8th Grade Experimental and Control Group Students

The findings and comments regarding the astronomy literacy levels of the students in the 8th grade study group are given below.

Findings and Comments on the Astronomy Literacy Levels Pretest and Posttest Scores of the 8th Grade Experimental Group Students

Is there a significant difference between the pretest and posttest scores of the 8th grade experimental group students' astronomy literacy levels? the t-test analysis results for the dependent samples related to the sub-problem are given in Table 9.

Table 9. *Dependent samples t-test results of pretest-posttest mean scores of 8th grade experimental group students' astronomy literacy levels*

	n	$\overline{X}$	ss	df	t	p	η^2
Pretest	26	40.57	8.46	25	-17.67	.00	.92
Posttest	26	66.73	3.90				

When Table 9 is examined, it is seen that there is a significant difference when the pretest-posttest mean scores of the 8th grade experimental group students' astronomy literacy levels are examined (t_{25} = -17,67, p = 0.00 < 0.05). The posttest mean score ($\overline{X}$ = 66.73) of the experimental group students was higher than the pretest mean score ($\overline{X}$ = 40.57). It has been seen that augmented reality applications make a positive contribution to students' astronomy literacy levels. It is possible to say that

the effect size of augmented reality applications on the average score of astronomy literacy levels is large (η^2 = .92).

Findings and Comments on the Astronomy Literacy Levels Pretest and Posttest Scores of the 8th Grade Control Group Students

Is there a significant difference between the pretest and posttest scores of the 8th grade control group students' astronomy literacy levels? the t-test analysis results for the dependent samples related to the sub-problem are given in Table 10.

Table 10. *Dependent samples t-test results of pretest-posttest mean scores of 8th grade control group students' astronomy literacy levels*

	n	$\overline{X}$	ss	df	t	p
Pretest	23	40.04	7.87	22	-7.55	.00
Posttest	23	45.69	6.52			

When Table 10 is examined, it is seen that there is a significant difference when the pretest-posttest mean scores of the 8th grade control group students' astronomy literacy levels are examined (t_{22} = -7,55, p = 0.00 < 0.05). The average score of the control group students after the application ($\overline{X}$ = 45.69) is higher than the scores before the application ($\overline{X}$ = 40.04).

Findings and Comments on the Astronomy Literacy Levels Pretest Scores of the 8th Grade Experimental and Control Group Students

Is there a significant difference between the pretest scores of the 8th grade experimental and control group students' astronomy literacy levels? the t-test analysis results for independent samples related to the sub-problem are given in Table 11.

Table 11. *Independent samples t-test results of pretest mean scores of 8th grade experimental and control groups students' astronomy literacy levels*

Group	n	$\overline{X}$	ss	df	t	p
Experimental	26	40.57	8.46	47	.22	.82
Control	23	40.04	7.87			

When Table 11 is examined, there is no significant difference between the average scores of the 7th grade students' pre-application astronomy literacy levels (t47 = .22, p = 0.82 > 0.05). The astronomy literacy scores of the experimental and control group students were close before the application.

Findings and Comments on the Astronomy Literacy Levels Posttest Scores of the 8th Grade Experimental and Control Group Students

Is there a significant difference between the pretest scores of the 8th grade experimental and control group students' astronomy literacy levels? the t-test analysis results for independent samples related to the sub-problem are given in Table 12.

Table 12. *Independent samples t-test results of the astronomy literacy levels posttest mean scores of the 8th grade experimental and control group students*

Group	n	$\overline{X}$	ss	df	t	p	η^2
Experimental	26	66.73	3.90	47	13.87	.00	.80
Control	23	45.69	6.52				

When Table 12 is examined, it is seen that there is a significant difference when the posttest mean scores of the 8th grade experimental and control group students' astronomy literacy levels are

examined (t_{47} = 13.87, p = 0.00 < 0.05). The posttest average score ($\overline{X}$ = 66.73) of the students working with augmented reality applications is higher than the posttest average score ($\overline{X}$ = 45.69) of the students working with the applications suggested in the textbooks. When the effect value of augmented reality applications is examined, it is seen that the eta square value (η^2 = .80) has a large effect value. Eta square (η2) value shows that this difference is not accidental (Cohen, 1988: 44).

Discussion and Conclusion

In this study, the astronomy literacy levels of the seventh and eighth grade students were determined and the effect of augmented reality (AR) applications on the astronomy literacy levels of the students was investigated. In this context, the following conclusions have been reached on the basis of the stated objective:

It was noted that the seventh and eighth grade students of secondary school had a low level of astronomy literacy before the application. After the application, it was observed that the astronomy literacy levels of the seventh and eighth grade experimental group students in the courses conducted with augmented reality applications reached a high level. It has been determined that augmented reality (AR) applications have a positive effect on students' astronomy literacy levels. After the application, it was seen that the astronomy literacy levels of the control group students in the lessons carried out with the applications and activities recommended in the textbooks reached the medium level. The astronomy literacy levels of the control group students were lower than those of the experimental group students. When the literature is examined, it is seen that AR applications are an effective method among teaching methods and contribute positively to the cognitive learning of students (Abdüsselam, 2014; Abdüsselam & Karal, 2012; Akçayır et al., 2016; Bressler & Bodzin, 2013; Buchner & Zumbach, 2018; Chen et al., 2015; Chiang et al., 2014; Enyedy et al., 2012; Fleck et al., 2014; Hsiao et al., 2012; İbili & Şahin, 2013; Küçük et al., 2014;Lin et al., 2013; Tarng et al., 2021). When the literature is examined, it is seen that AR applications contribute positively to students' affective acquisitions such as attitude, interest and motivation (Buluş Kırıkkaya & Şentürk, 2018; Duman & Öncü, 2016; Delello, 2014; Ersoy , Huang, et al., 2016; Furió et al., 2015; Hsiao et al., 2012; Ibanez et al., 2014; Khan, et al., 2019; Megahed, 2014; Onur, 2021; Özeren, 2020; Pozharına, 2019; Tandoğan, 2019). It was observed that students achieved a higher motivation and success after Özeren (2020) realized with the AR material named CellAR. However, in the studies conducted by Eren (2019), Yetişir (2019) and Türksoy (2019), results were reached that AR applications increase the permanence of knowledge. Discovery Kırıkkaya and Şentürk (2018) concluded that there is a significant difference in academic achievement levels in favor of the experimental group students, as a result of the fact that the Science course solar system and beyond unit teaching was carried out with AR supported application. According to the results of the study, it can be said that augmented reality applications are effective on students' astronomy literacy levels. The partial effect size value also supports the result of the study. The literacy of the science of astronomy, which started from ancient times and became increasingly important with rapidly developing technology, is an important part of scientific literacy. In this context, studies on the development of astronomy literacy in individuals are very important.

Recommendations

According to the results obtained in this study, various suggestions were made to practitioners, program developers and researchers:

Recommendations for practitioners:

• As a result of this research conducted to determine the astronomy literacy levels of students and the effect of augmented reality (AR) applications on students' astronomy literacy levels; It was determined that the students' astronomy literacy levels were low before the application. In this regard, more space should be given to augmented reality applications that will increase students' astronomy literacy levels.

• The study included activities to increase the astronomy literacy levels of 7th and 8th grade secondary school students. In future studies, studies that will enable students to realize their astronomy talents at all levels of education can be included.

Recommendations for program developers:

• In Science courses, where the aim is to provide cognitive gains related to astronomy, practices aimed at gaining more cognitive, affective and behavioral gains can be included while preparing the gains and curriculum.

Recommendations for researchers:

• One of the limitations of the study is that different demographic characteristics were not taken into account in the research. By examining astronomy literacy levels in terms of different socio-demographic variables, the effects of these variables on astronomy literacy and the dimensions of this effect can be investigated.

• Including activities that increase the astronomy literacy levels of secondary school 7th and 8th grade students is among the limitations of the study. Experimental studies can be conducted to ensure and observe the development of astronomy literacy levels of individuals at all levels of education.

• Astronomy literacy levels of students studying in primary school, secondary school, high school or higher education can be examined and these levels can be compared among themselves.

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Artırılmış Gerçeklik Uygulamalarının Ortaokul Öğrencilerinin Astronomi Okuryazarlık Düzeylerine Etkisinin İncelenmesi

Giriş

"Astronomi okuryazarlığı" kavramı, bireyin temel astronomi kavramlarının bilişsel boyutu ile beraber davranışsal ve duyuşsal boyutları hakkında çok boyutlu becerilere sahip olmaktır. Astronomi okuryazarı bir birey; bilişsel boyut açısından temel astronomi konularında kavramsal bilgiye; duyuşsal boyut açısından astronomiye yönelik olumlu tutum, ilgi ve motivasyona; davranışsal boyut açısından ise astronomi ile ilgili gözlem, katılım ve eyleme sahip olmalıdır.

Astronomi kavram ve konularının öğretiminde teknoloji ve uygulamalarının kullanılması, soyut kavramların somutlaştırılması ve görülmesi, zor konuların anlaşılması, duyuşsal ve davranışsal hedeflerin kazandırılması açısından çok önemli bir rol almaktadır. Öğrencinin öğretim sürecinde daha aktif olabilmesi, kazanımlara daha etkili bir şekilde ulaşabilmesi, verimin artması ve geniş kitlelere yönelik eğitim hizmetinin sunulması eğitimde teknoloji kullanımının temel hedefleridir (Baysal, 2016). Belirtilen hedefler dikkate alındığında, Fen bilimleri kavram ve konularının öğretiminde teknolojinin yer almasının ve kullanımının, öğrenmeyi daha kolay hale getirdiği, kalıcı etkili ve anlamaya dayalı öğrenme etkisiyle eğitime katkısının olduğu anlaşılmaktadır (Çankaya, 2019).

Yapılan birçok araştırma, teknoloji ve uygulamalarının öğretim yöntem ve stratejilerine zenginlik kattığını, öğrencilerin aktif bir şekilde öğrenme sürecinde olduğunu ve karşılıklı etkileşimi sağlayarak eğitimin daha verimli hale gelmesinde katkı sunduğunu ortaya koymuştur (Küçüksaraç & Sayımer, 2016). Özellikle son yıllarda Fen eğitiminde teknoloji ve uygulamalarına daha fazla yer verilmektedir. Ancak eğitimde en az kullanılan materyallerden ancak eğitime güçlü bir katkı sağlayacak yöntem ve tekniklerden biri artırılmış gerçeklik [AG] teknolojisidir (Sarıca, 2019). AG uygulamaları, gerçek dünyayla bağlantısını kesmeksizin sanal nesne ve içeriklerin gerçek ortam görüntülerine dahil edildiği, hem gerçek hem de sanal nesnelerin beraber bir ortamda görülmesini sağlayan bir teknolojidir

(İçten & Bal, 2017). Bu çalışmada, ortaokul yedinci ve sekizinci sınıf öğrencilerinin astronomi okuryazarlık düzeylerinin tespit edilmesi ve öğrencilerin astronomi okuryazarlık düzeyleri üzerine artırılmış gerçeklik (AG) uygulamalarının etkisinin araştırılması amaçlanmaktadır.

Yöntem

Araştırmada yarı deneysel yöntem (quasi-experimental research) ve öntest-sontest kontrol gruplu deneysel desen kullanılmıştır (Büyüköztürk, 2011). Bu çalışmada, deney grupları üzerinde etkisi incelenen bağımsız değişken, artırılmış gerçeklik uygulamalarıdır. Kontrol gruplarında ise, Fen Bilimleri dersi öğretim programında önerilen uygulamalardır. Gruplardaki bağımlı değişken ise, astronomi okuryazarlık düzeyidir. Araştırmada, çalışmaya katılan öğrencilerin astronomi kavramları temelinde, astronomi okuryazarlık düzeyleri öğrenme sürecinden önce ve sonra izlenmiştir. Deneysel araştırmaların temel özelliği bağımsız değişkenlerin kontrol edilebilmesidir (McMillan, 2000, s. 207). Bu araştırmada, olasılık temelli olmayan örnekleme yöntemi kullanılarak, uygun örnekleme yöntemine göre çalışma grubu seçilmiştir. Bu yöntemde, katılımcılar araştırmacının kolay ulaşabileceği, araştırma için gönüllü ve uygun bireyler arasından seçilmektedir (Gravetter & Forzano, 2012). Çalışma grubu, 2021-2022 eğitim-öğretim yılı bahar döneminde Ankara ili merkez ilçesinde bir devlet ortaokulunda öğrenim gören yedinci ve sekizinci sınıf öğrencilerinden ($n_{7.sınıf} = 46$ ve $n_{8.sınıf} = 49$) oluşmaktadır. Çalışma süresince iki deney, iki kontrol grubu olmak üzere dört ayrı sınıf ile çalışılmıştır. Araştırmanın verileri SPSS istatistik programı ile analiz edilmiştir.

Bulgular

Araştırmadan elde edilen verilerin analizi sonucunda ortaokul yedinci ve sekizinci sınıf öğrencilerinin uygulama öncesi astronomi okuryazarlık düzeylerinin düşük seviyede olduğu dikkat çekmiştir. Uygulama sonrasında artırılmış gerçeklik uygulamaları ile yürütülen derslerde deney grubu yedinci ve sekizinci sınıf öğrencilerinin astronomi okuryazarlık düzeylerinin yüksek düzeye ulaştığı gözlenmiştir. Artırılmış gerçeklik [AR] uygulamalarının öğrencilerin astronomi okuryazarlık düzeyleri üzerinde olumlu bir etkiye sahip olduğu tespit edilmiştir. Uygulama sonrasında kontrol grubu öğrencilerinin MEB ders kitaplarında önerilen uygulamalarla yürütülen derslerde astronomi okuryazarlık düzeylerinin orta düzeye ulaştığı görülmüştür. Kontrol grubu öğrencilerinin astronomi okuryazarlık düzeyleri deney grubu öğrencilerine göre daha düşüktür. Özellikle deney grubu öğrencilerinin; astronomi okuryazarlık düzeylerinin duyuşsal ve davranışsal boyutunun oldukça yüksek düzeyde geliştiği ortaya çıkmıştır.

Tartışma ve Sonuç

AG uygulamalarının öğretim yöntemleri arasında etkili bir yöntem olduğu ve öğrencilerin bilişsel, duyuşsal ve davranışsal öğrenmelerine olumlu katkı sağladığı görülmektedir (Abdüsselam, 2014; Abdüsselam & Karal, 2012; Akçayır et al., 2016; Bressler & Bodzin, 2013; Buchner & Zumbach, 2018; Chen et al., 2015; Chiang et al., 2014; Enyedy et al., 2012; Fleck et al., 2014; Hsiao et al., 2012; İbili & Şahin, 2013; Küçük et al., 2014;Lin et al., 2013; Tarng et al., 2021). Uygulamalarının bilginin kalıcılığını artırdığı yönündeki sonuçlara ulaşılmıştır. Buluş Kırıkkaya ve Şentürk (2018) Fen Bilimleri dersi güneş sistemi ve ötesi ünitesi öğretiminin AG destekli uygulama ile gerçekleştirilmesi sonucu deney grubu öğrencileri lehine akademik başarı düzeylerinde anlamlı bir fark olduğu sonucuna ulaşmıştır. Çalışma sonuçlara göre, artırılmış gerçeklik uygulamalarının, öğrencilerin astronomi okuryazarlık düzeyleri üzerinde etkili olduğu söylenebilir. Kısmi etki büyüklüğü değeri de, çalışmanın sonucunu destekler

niteliktedir. Alanyazın incelendiğinde, AG uygulamalarının öğrencilerin tutum, ilgi, motivasyon gibi duyuşsal kazanımlarına olumlu katkı sağladığı görülmektedir (Buluş Kırıkkaya & Şentürk, 2018; Duman & Öncü, 2016; Delello, 2014; Ersoy , Huang, et al., 2016; Furió et al., 2015; Hsiao et al., 2012; Ibanez et al., 2014; Khan, et al., 2019; Megahed, 2014; Onur, 2021; Özeren, 2020; Pozharına, 2019; Tandoğan, 2019). Özeren (2020) HücreAR adlı AG materyali ile gerçekleştirmesi sürecinden sonra öğrencilerin daha yüksek bir motivasyon ve başarı elde ettikleri görülmüştür. Eski çağlardan başlayan ve hızla gelişen teknoloji ile önemi giderek artan astronomi biliminin okuryazarlığı, bilimsel okuryazarlığının önemli bir parçasıdır. Bu bağlamda, bireylerdeki astronomi okuryazarlığının geliştirilmesine yönelik yapılan çalışmalar oldukça önemlidir.

Öneriler

Bu araştırmada elde edilen sonuçlara göre; çeşitli önerilerde bulunulabilir: Öğrencilerin astronomi okuryazarlık düzeylerinin tespit edilmesi ve öğrencilerin astronomi okuryazarlık düzeyleri üzerine artırılmış gerçeklik (AG) uygulamalarının etkisini tespit etmek üzere yapılan bu araştırma sonucunda; uygulama öncesi öğrencilerin astronomi okuryazarlık düzeylerinin düşük olduğu belirlenmiştir. Bu bakımdan öğrencilerin astronomi okuryazarlık düzeylerini arttıracakları artırılmış gerçeklik uygulamalarına daha çok yer verilebilir. Çalışmada ortaokul 7. ve 8. sınıf öğrencilerinin astronomi okuryazarlık düzeylerini artırıcı etkinliklere yer verilmiştir. Daha sonraki çalışmalarda, eğitimin her kademesinde, öğrencilerin astronomiye yönelik yeteneklerini fark etmelerine olanak tanıyacak çalışmalar yapılabilir.

Appendix

Appendix 1. Astronomy Literacy Scale

CHAPTER 1 (Astronomy Literacy Self-Perception)

1. How much do you think you know about astronomy?

A. Too much

B. More

C. Intermediate

D. Not much

E. None

2. How would you describe yourself about doing studies/research on astronomy?

A. I do a lot of study/research.

B. I do more work/research.

A. I do a moderate amount of study/research.

D. I don't do much study/research.

E. Never

3. Which of the following contributes the most to learning the subjects and concepts related to astronomy?

A. Lessons at school

B. Internet

C. Television

D. Article/book/magazine/newspaper

E. Family/Friends

4. Which of the following do you talk about studies, researches or subjects related to astronomy?

A. Teachers

B. Friends

C. Family

D. People in the virtual environment

E. Nobody

5. How often do you talk to people around you about astronomy-related topics?

A. Too much

B. More

C. Intermediate

D. Not much

E. None

CHAPTER 2 (The Affective Dimension of Astronomy Literacy)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. 1. I am interested in astronomy.					
2. 2. I enjoy learning new information about astronomy.					
3. 3. I can easily learn the concepts and subjects related to astronomy.					
4. 4. I make mistakes when explaining astronomy concepts.					
5. 5. Astronomy has no contribution to my daily life.					
6. 6. I don't want to work on the sky.					

CHAPTER 3 (The Behavioral Dimension of Astronomy Literacy)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
7. 1. I observe the sky using sky survey programs (Google sky, sky map, NASA, sky walk etc.).					
8. 2. I watch the sky with the naked eye (without any observation tool) at night when the weather conditions are suitable.					
9. 3. I follow the astronomer or astronauts who work on the sky on social media.					

CHAPTER 4 (Cognitive Dimension of Astronomy Literacy)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
10. 1. I can express the geometric shape of the sun.					
11. 2. I can explain the direction, duration and consequences of the Sun's rotation.					
12. 3. I can express the geometric shape of the Earth.					
13. 4. I cannot tell the size of the moon.					
14. 5. I can explain the moon's age.					
15. 6. I can express the geometric shape of the moon.					
16. 7. I cannot explain how stars are formed.					