Turkish Journal of Teacher Education

Volume 13, Issue 1, 2024 e-ISSN: 2147-5156

Examining the Effect of Out-Of-School Learning Activities on Attitude towards Astronomy

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Keywords

Out-of-School Learning, Astronomy Education, Science Education

Article History

Received May 14, 2024
Revised June 22, 2024
Accepted June 24, 2024
Published June 30, 2024

Abstract

This study examined middle school students' attitudes towards astronomy in the 7th grade 'Solar System and Beyond' unit in out-of-school learning environments. We used the pre-test-post-test control group model, among the semi-experimental models, and the 'Attitudes Towards Astronomy Scale (ATAS) as the measurement tool. We conducted the study with 70 students studying at the 7th-grade level in a state middle school in the Pamukkale District of Denizli Province in the 2023-2024 Academic Year. In addition, we applied some out-of-school learning activities such as planetarium, observatory, and sky observations to the students in the experimental group. We used a t-test to solve the sub-problems of the research for independent groups. Based on the results, we concluded that there was a statistically significant difference of .05 in favor of the experimental group's attitudes toward astronomy. This difference indicates that the activities carried out for the experimental group's learning environments outside of school are more effective than the control group's inside-of-school environments.

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**This paper was produced from a part of the first researcher's doctoral thesis, which was conducted under the supervision of the second author.

Introduction

Learning is a behavioral change that occurs due to experience and has a permanent trace. Accordingly, it is expected that learning is a change in the behavior of the individuals, that this change is not because of various factors, and that it is permanent for at least a certain period (Acikgoz, 2003; Demirel, 2005). Since the 19th century, the learning process has been carried out within structures called 'schools' with specific rules and programs. The learning process in these structures, in line with specific programs, rules, and plans, is expressed as formal learning (Sen, 2021). However, an individual's learning is a process that is too broad and comprehensive to be confined to certain hours, patterns, and structures. Especially in today's world, where communication and transportation tools have developed rapidly, accessing information has become very easy. Therefore, learning takes place in every piece of our lives. Humanity, which has solved the problem of accessing information, has focused its research on learning and making information permanent. With the developments in education and training, there have been significant changes in learning and teaching methods and techniques. For effective learning to occur, the boundaries of the classroom and school have been exceeded, and the idea that all kinds of out-of-school learning environments can be helpful for this purpose has emerged (Sarac, 2017). Eshach (2007) stated that 85% of a student's day is spent outside of school, and therefore, when students' success is considered, both their in-school and out-of-school experiences are compelling in their learning processes. In this context, museums, planetariums, zoos, and science centers, especially in science education, are expressed as out-of-school learning environments (Fenichel & Schweingruber, 2010; NRC, 2009).

The most critical and mysterious branch of science in human history is astronomy. One of the biggest reasons for this is that the objects of the eye are very far away and 'unreachable'. Despite this, people have started to observe the sky since very old times. They made calendars by looking at the movements of the Sun and the Moon. They organized their agricultural, industrial, and navigation activities according to the movements of celestial bodies. However, these behaviors were based on a scientific basis much later. Although humanity has collected reliable and valuable data from observations of the sky since ancient times, it took them much longer to produce scientific theories explaining the reasons for these observations. They suggested that the movements of celestial bodies were some myths that affected people's destinies. Even the Babylonians' sky observations could not go further than astrological prophecies (Ozel & Saygac, 2020; Yildirim, 2008). Astronomy is a branch of science. It can be defined as understanding the functioning of our planet, other celestial bodies, and the entire universe (Pasachoff & Percy, 2010; Tascan & Unal, 2015). According to this definition, observation and technology come to the fore in astronomy. In addition, astronomy education is defined as a pedagogical research field that aims to improve the methods currently used to teach astronomy and these methods. Although it is emphasized that the quantity and quality of astronomy taught in schools is vital, it is stated that in many countries, astronomy topics are either not included in the programs at all or the teachers who cover these topics in classes do not have sufficient equipment on the subject despite being included in the programs (Bailey & Lombardi, 2015; Fraknoi, 2014; Pasachoff & Percy, 2010; Tascan & Unal, 2015).

While astronomy topics covered in the classroom, within school walls, are theoretically beneficial to students, observations made outdoors or in out-of-school environments equipped with technology, such as the planetarium, are expected to develop positive attitudes towards astronomy. On the other hand, a study conducted by TUBITAK to measure scientific literacy in Türkiye revealed that astronomy is one of the topics that young people between the ages of 15 and 24 are most interested in (MNE, 2010).

In Türkiye, astronomy topics are taught as part of the science course at primary and middle school levels. Astronomy topics, which were taught as the last unit of the science course until 2018, started to be taught as the first unit of the science course under the subject area of 'Earth and the Universe' at all grade levels after the program changed in 2018 (MNE, 2018). The 7th-grade level is where astronomy topics are taught most intensively. At the same time, students encounter concepts such as space pollution, stars and their formation processes, nebulas, and black holes for the first time at this grade level. The broader scope of the 'Solar System and Beyond Unit (SSBU),' taught as the first unit at the 7th-grade level, was particularly effective in conducting the study with 7th-grade students.

The problem statement of this study was 'What is the effect of education supported by out-of-school learning environments on students' attitudes towards astronomy in the middle school 7th grade 'Solar System and Beyond (SSBU)' unit?' Accordingly, the sub-problem of the study is whether there is a significant difference between the student's attitudes towards astronomy before and after the experimental intervention.

Methods

This study used the pretest-posttest control group model, a quasi-experimental research design, because the classes were determined in advance. This model does not involve random assignment. Researchers who use these designs instead rely on other techniques to control (or at least reduce) threats to internal validity (Fraenkel et al., 2011). The experimental design of the study is shown in Table 1.

Table 1
The Experimental Design Used in The Study

Group	Pre-Test	Experimental Procedure	Post-Test
Experimental Group	Attitude Towards Astronomy Scale (ATAS)	Curriculum supported by out-of-school learning environments	Attitude Towards Astronomy Scale (ATAS)
Control Group		Science course curriculum	

The Sample

We conducted the research with 70 7th-grade students studying in a state middle school in Pamukkale District of Denizli Province in the 2023-2024 academic year. Table 2 shows the distribution of students participating in the study in the experimental and control groups according to gender.

Table 2

The Distribution of Students in the Study for Experimental and Control Groups According to Gender

Gender	Experimental Group	Control Group	Total
Female	16	16	32
Male	18	20	38
Total	34	36	70

Data Collection Tool

The study used the 'Attitude Towards Astronomy Scale' (ATAS) developed by Ucar and Aktamis (2019) as a data collection tool. The researchers first conducted a literature review on the subject in order to create an item pool. After this stage, they consulted eight experts, including science teachers, linguists, and academicians specializing in astronomy and space sciences. The created 68-item scale was applied to 380 students at the middle school level in order to conduct validity and reliability studies. As a result of the exploratory factor analysis, ATAS has a three-dimensional structure. There are 14 items in total in a 5-point Likert-type scale consisting of items numbered 'Enjoyment of Sky Observation' (1, 2, 3, 4, 5, 6), 'Interest in Media Literacy' (7, 8, 9, 10), and 'Curiosity about Space' (11, 12, 13, 14). The total variance explained by these three factors is 65.58%. The contribution of the determined total variance to each factor is 27.36%, 19.66%, and 18.55%, respectively. As a result of the reliability analyses, the Cronbach alpha reliability coefficient of the whole scale was found to be .91. In addition, the Cronbach alpha reliability coefficient for each sub-dimension of the measurement tool was calculated as .88 for the first sub-dimension, .81 for the second sub-dimension, and .84 for the third sub-dimension.

Data Collection Procedures

At the beginning of the intervention process, we applied the ATAS to the students in the experimental and control groups as a pre-test. During the unit, the first researcher taught the students in the experimental group with out-of-school learning activities developed by both researchers. Within the scope of the activities, the students were in out-of-school learning environments such as planetarium, observatory, sky observation with a telescope in the open air, and also in university.

The activities consist of three stages: pre-activity, during the activity, and post-activity. The subjects were covered with worksheets distributed to the students at each stage. In addition, the students in the experimental group were asked to keep a science journal after each activity. In this context, the students were informed about the science journal. The unit was taught as included in the curriculum with the students in the control group. At the end of the study, we applied the ATAS to the students in the experimental and control groups as a post-test.

Data Analysis

We analyzed the data obtained from the data collection tools used in the study with the SPSS 20.00 program. First, the descriptive statistical analyses of the data obtained from ATAS were performed, and their arithmetic means and standard deviations were given. Then, it was tested with the statistical analysis based on inference (t-test) for independent groups at a significance level of .05. Eta-square and Cohen d (d) were used for the independent sample t-test in reporting the effect size index.

The t-test for independent groups is one statistical analysis that can be used to determine whether there is a significant difference between the measurements taken with the same measurement tool and the group means (Turgut, 2009).

Results

This section includes the results obtained from the ATAS, used as a data collection tool in the study. The scores of the students in the experimental and control groups obtained from the ATAS before the experimental procedure were evaluated with the Independent Groups t-test, a parametric statistical method. The t-test for independent groups requires the following assumptions: a) The two groups are independent of each other b) The dependent variable is measured at the interval or ratio scale level c) The distribution of raw scores of the universe represented by each sample is normally distributed d) The variances of the universes represented by the sample are homogeneous (Buyukozturk et al., 2019).

Therefore, Table 3 provides descriptive statistics showing whether the scores of the experimental and control group students from the ATAS administered before the experimental procedure met the assumptions of the t-test.

Table 3
Descriptive Statistics on ATAS Pre-Test Scores

Factors	Groups	n	$\bar{x}$	Median	Mode	sd	Skewness
Enjoyment of Sky Observation	Experimental Group	34	25.38	26	29	4.25	-1.070
	Control Group	36	22.47	24	24	5.24	-0.454

Interest in Media Literacy	Experimental Group	34	12.55	12	12	3.70	-0.092
	Control Group	36	11.80	12	14	4.11	-0.174
Curiosity about Space	Experimental Group	34	15.35	17	20	4.58	-0.800
	Control Group	36	15.02	16	18	4.24	-0.931
ATAS Pre-Test Scores	Experimental Group	34	53.29	54	48	10.40	-0.353
	Control Group	36	49.30	52	39	10.80	-0.310

Table 3 shows that the mean, median, and peak values of the students in the experimental and control groups from ATAS and its sub-dimensions at the beginning are close.

The coefficient of skewness(S) related to the data in the experimental group is (S: -1.070) for the sub-dimension named 'Enjoyment of Sky Observation' (S: -0.092) for the sub-dimension named 'Interest in Media Literacy' (S: -0.800) for the sub-dimension named 'Curiosity about Space' and (S: -0.353) for the whole scale. The coefficient of skewness(S) related to the data in the control group for the sub-dimension named 'Enjoyment of Sky Observation' (S: -0.454), for the sub-dimension named 'Interest in Media Literacy' (S: -0.174), for the sub-dimension named 'Curiosity about Space' (IQ: -0.931), and for the entire scale (S: -0.310). The skewness coefficient value within the range of ±2 indicates that the data have a normal distribution (George & Mallery, 2010). Table 3 shows that the groups meet the assumption of normal distribution. After this assumption was met, Levene's Variance Equality Test was used to examine whether the universe variances represented by the samples were homogeneous. Levene Test results showed that the universe variances were homogeneous for all sub-dimensions. For the sub-dimension named 'Enjoyment of Sky Observation' (F=2.063, p=0.155), for the sub-dimension named 'Interest in Media Literacy' (F=0.960, p=0.331), for the sub-dimension named 'Curiosity about Space' (F=0.652, p=0.422), and for the entire scale (F=0.020, p=0.888).

After all these assumptions were met, an independent sample t-test was performed. The groups' t-test results are given in Table 4.

Table 4

Independent Groups t-Test Results Regarding Pre-Test Scores of ATAS and Its Sub-Factors

Factors	Group	n	$\bar{x}$	sd	f	p	Significant Difference
Enjoyment of Sky Observation	Experimental Group	34	25.38	4.25	2.063	0.013*	Experimental group*
	Control Group	36	22.47	5.24			
Interest in Media Literacy	Experimental Group	34	12.55	3.70	0.960	0.424	There is no significant difference.
	Control Group	36	11.80	4.11			

Curiosity about Space	Experimental Group	34	15.35	4.58	0.652	0.759	There is no significant difference.
	Control Group	36	15.02	4.24			
ATAS Pre-Test Scores	Experimental Group	34	53.29	10.40	0.020	0.121	There is no significant difference.
	Control Group	36	49.30	10.80			

*p<.05

Table 4 shows that a significant difference has emerged in the sub-dimension of ATAS called 'Enjoying Sky Observation' (F=2.063; p<.05). It is also seen that there is a remarkable difference in favor of the experimental group.

Descriptive statistics showing whether the scores of the experimental and control group students from the ATAS and its sub-dimensions applied after the experimental procedure meet the assumptions of the t-test are given in Table 5.

Table 5

Descriptive Statistics on ATAS Post-Test Scores

Factors	Groups	n	$\bar{x}$	Median	Mode	sd	Skewness
Enjoyment of Sky Observation	Experimental Group	34	26.5	27	30	3.58	-0.630
	Control Group	36	21.88	23	30	5.88	-0.347
Interest in Media Literacy	Experimental Group	34	13.8	13	20	4.46	-0.142
	Control Group	36	11.16	11.5	8	4.51	0.068
Curiosity about Space	Experimental Group	34	16.91	18.5	20	3.54	-0.911
	Control Group	36	13.91	14	16	4.66	-0.494
ATAS Post-Test Scores	Experimental Group	34	57.20	59	70	9.81	-0.345
	Control Group	36	46.97	48	54	11.87	-0.203

Table 5 and the scores of the students in the experimental and control groups from ATAS and its sub-dimensions show that the groups' mean, median, and peak values are close to each other. The coefficient of skewness(S) related to the data in the experimental group is (S: -0.630) for the sub-dimension named 'Enjoyment of Sky Observation,' (S: -0.347) for the sub-dimension named 'Interest in Media Literacy,' (IQ: -0.911) for the sub-dimension named 'Curiosity about Space,' and (S: -0.345) for the whole scale. The coefficient of skewness(S) related to the data in the control group for the sub-dimension named 'Enjoyment of Skywatching' (S: -0.347), for the sub-dimension named 'Interest in Media Literacy' (S: 0.068), for the sub-dimension named 'Curiosity about Space' (IQ: -0.494), and for the entire scale (S: -0.203). The skewness coefficient value within the range of ±2 indicates that the data have a normal distribution (George & Mallery, 2010). Table 5 also shows that the groups meet the assumption of normal distribution. Levene's Test for Equality of Variances was used to examine whether the universe variances represented by the samples were homogeneous. The Levene Test results showed that the universe variances were homogeneous for all sub-dimensions except for the 'Enjoyment of Skywatching sub-dimension.'However, since the t-test is a parametric solid test, it can be used even if the assumption of homogeneity of variances is not met (Buyukozturk et al., 2019). For the sub-dimension named 'Enjoyment of Sky Observation' (F=9.010, p=0.004), for the sub-dimension named 'Interest in Media Literacy' (F=0.000, p=0.994), for the sub-dimension named 'Curiosity about Space' (F=1.678, p=0.200), and for the entire scale (F=0.818, p=0.368).

After all these assumptions were met, an independent sample t-test was performed. The groups' t-test results are given in Table 6.

Table 6

Independent Groups t-Test Results Regarding Post-Test Scores of ATAS and Its Sub-Factors

Factors	Group	n	$\bar{x}$	sd	f	p	Significant Difference
Enjoyment of Sky Observation	Experimental Group	34	26.5	3.58	9.010	0.000*	Experimental group*
	Control Group	36	21.88	5.88			
Interest in Media Literacy	Experimental Group	34	13.8	4.46	0.000	0.017*	Experimental group*
	Control Group	36	11.16	4.51			
Curiosity about Space	Experimental Group	34	16.91	3.54	1.678	0.004*	Experimental group*
	Control Group	36	13.91	4.66			
ATAS Post-Test Scores	Experimental Group	34	57.20	9.81	0.818	0.000*	Experimental group*
	Control Group	36	46.97	11.87			

*p<.05

Table 6 shows that remarkable differences were found in the sub-dimension of ATAS called 'Enjoyment of Sky Observation' (F=9.01; p<.05); in the sub-dimension called 'Interest in Media Literacy' (F=0.00; p<.05); in the sub-dimension called 'Curiosity about Space' (F=1.678; p<0.05) and in the total scores obtained from the entire scale (F=0.81; p<.05). It is also seen that there is a significant difference in favor of the experimental group in all sub-dimensions of the ATAS and the total scores obtained from the entire scale.

When we calculated the effect size of this result, d=0.95; eta squared=0.185 was found for the sub-dimension 'Enjoying Sky Observation.' Accordingly, the distance between the means is .95 standard deviation; depending on the application, 18% of the variance of the scale scores arises. The calculated effect sizes reflect a significant effect.

When we calculated the effect size for the sub-dimension, ' Interest in Media Literacy,' d=2.18; eta squared=0.081 was found. Accordingly, the distance between the means is 2.18 standard deviations; depending on the application, 8% of the variance of the scale scores arises. The calculated effect sizes reflect a medium effect.

When we calculated the effect size for the sub-dimension 'Curiosity about Space,' d=0.72; eta squared=0.118 was found. Accordingly, the distance between the means is 0.72 standard deviations; 12% of the variance of the scale scores arises due to the application. The calculated effect sizes reflect a medium effect.

When we calculated the effect size of the scores obtained from the entire scale, d=0.94; eta squared=0.184 was found. Accordingly, the distance between the means is 0.94 standard deviations; 18% of the variance of the scale scores arises due to the application. The calculated effect sizes reflect a significant effect.

Discussion & Conclusion

This study aims to observe the changes in students' attitudes towards astronomy when the 7th-grade middle school science course 'Solar System and Beyond' unit is taught with out-of-school learning activities. Although a significant difference emerged in favor of the experimental group in the sub-dimension of ATAS, which was implemented before the intervention, no difference was found in the other sub-dimensions of the scale or the entire scale. This sub-dimension includes questions such as liking sky observations, watching lunar and solar eclipses, and liking sky photographs. In this context, it is thought that the students in the experimental group are a student group that enjoys sky observations more. After the application, differences at a significance level of .05 emerged in favor of the experimental group in all ATAS sub-dimensions and the entire scale. During the intervention, out-of-school activities designed by both the researchers and the students in the experimental group were included. In line with these activities, the students took part in activities such as a planetarium, observatory, panels given by expert academicians in the university, and sky observation in the open air within the scope of the unit. The students in the experimental group were also provided worksheets to be applied to 'Pre-Activity, During the Activity, Post-Activity' within the scope of the activities. In addition to all these, the students in the experimental group filled out reflective science journals in which they shared their impressions at the end of each activity.

The students in the control group were not subjected to any of these activities, and the unit topics were covered as included in the Science Course Curriculum. When the literature is examined, studies have found that the topics covered with out-of-school learning activities have positively changed the attitudes of students (Aydin, 2019; Cabello & Ferk Savec, 2018; Gundogdu, 2014; Henriksson, 2018; Kilic, 2020; Kucuk, 2020; Metin, 2020). Out-of-school learning environments provide effective and permanent learning opportunities, allowing students to learn by doing and experiencing real-life problems. However, despite all these advantages, teachers and school administrators do not prefer them. The main reasons for this are crowded classrooms, the cost of trips, and the difficulties in the planning phase (Kucuk, 2020; Soylu & Karamustafaoglu, 2020).

However, despite all these difficulties, Braund and Reiss (2006) stated that science education is in a crisis, especially in developed countries. They noted that traditional science education in schools consists of boring and outdated topics and cannot attract students' attention. In terms of students, they noted that science and knowledge have become a field in which only a specific segment of society is interested, especially students who aim for a much higher career in this field. On the contrary, they stated that science centers, botanical gardens, parks, museums, and application centers attract much more attention from students. However, as encountered in this study, when designing out-of-school activities, especially on topics related to astronomy, it is of great importance to have out-of-school learning environments such as planetariums and observatories in the city where the school is located. Otherwise, these activities are thought to be challenging to carry out.

Based on the results, we want to make some suggestions: (i) this study was conducted in only one school with a very narrow sample. Therefore, the effects of the geography where the students live, and their families' demographic and socio-economic characteristics were excluded from the scope of the study. These conditions can also be considered in future studies on this subject. (ii) In this study, out-of-school learning environments such as a planetarium, open-air sky observation, observatory trip, and university panel were used. Other out-of-school learning environments can be preferred in future studies on this subject. (iii) This study includes topics related to astronomy in out-of-school learning environments. Other topics covered in science courses can also be included in future studies.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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