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DETERMINATION OF THE EFFECT OF THE PLANETARIUM ACTIVITIES ON THE STUDENTS

Salih Gülen[i]
Dr., Mus Alparslan University,
Malazgirt Vocational School,
Muş, Turkey

Abstract:
The purpose of this research is the determination of the effect of the activities of the planetarium on students' views, three-dimensional thinking skills and academic achievement. Mixed method was used in the research. The embedded pattern is preferred because qualitative data are supported by quantitative data that was used a single group pre-posttest experimental design. Homogeneous sampling was used in the study. A fully structured interview form and a three-dimensional thinking skill form have been prepared for the qualitative data. An academic achievement test has been developed for the quantitative data. Both descriptive and content analyses were done with frequency and Wilcoxon signed test techniques outside of the code-category and theme. Interpretation of the findings; as a result of planetarium activities in general, it has been found that the majority of students use positive expressions. It has been determined that the three dimensions skills of students is low in terms of size, distance and relationship dimensions between the Solar System and the planets. It has been determined that the same students' three dimensional thinking skills for the Earth and its satellite are high in size and distance dimensions but in relations and three dimensions complete are middle. It has been discovered that activities in the planetarium have increased academic achievement at both the seventh and eighth grade. Planetarium activities as a coincidence in the result of the research have an effect on eliminating the misconceptions of the students. Suggestions are made according to the study result.

Keywords: planetarium activities, three-dimensional thinking skills, students' views, academic achievement, Solar System and beyond

[i] Correspondence: email sgnova@windowslive.com

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1. Introduction

The science lessons aims to acquire knowledge that an individual can understand and use in his daily life. Activities such as experiments, observations, laboratory applications or planetarium activities are carried out to achieve this aim. These activities, which are known as out-of-school educational activities, provide for the strengthening of learning as an educational activity in practice (Bodur and Yıldırım, 2018; Gülen, 2018). Especially when it comes to issues such as the Solar System and beyond that are difficult to reach, it is essential to create suitable environments for accessing information. Because of it is difficult to understand and learn about these subjects (Chen, Yang, Shen and Jeng, 2007). Therefore, the use of three dimensional models (Türk and Kalkan, 2017), interactive applications (Ayaz and Demirkuş, 2017), the use of scientific and visual video works and planetarium activities are helping to reach this aim (Demirkuş and Gülen, 2017).

The planetarium developed to study virtually the concepts of the Solar System and beyond, is a structure with a dome-shaped screen that allows for a cinevision (Ertaş and Şen, 2011). These structures provide students with virtual environment and three dimensional materials (Sontay, Tutar and Karamustafaoglu, 2016). Planetariums offer opportunities for informing, especially for students (Hufnagel et al., 2000). Scientific, educational and practical activities are being carried out in the planetarium to reach scientific data.

Planetarium activities, make connections between the individual's own life and the data to be learned (Sontay, Tutar and Karamustafaoglu, 2016), create true and scientific thoughts (Tascan and Ünal, 2015), It affects three-dimensional thinking and the position of the object in the universe (Türk, 2018). The most basic goal in these activities is to visualize the data so that the individual can feel in himself (Gilbert, 2005). For this purpose, visual, auditory and descriptive materials are used as much as possible (Demirkuş, 2018). These materials especially improve the individual's skills to think in three dimensions.

Three-dimensional thinking is the ability of an individual to recognize objects with visual and spatial structures (Pittalis and Christou, 2010). Here, size, distance and relationship are important. Size; is about the celestial objects being represented or proportionally drawn in Solar System and beyond. Distance; are to be specified or proportional to the distance between them in Solar System and beyond. Relationship; is the relationship between the celestial bodies in the Solar System and beyond, ie their role in the environment. The subject is to be able to think spatially with concepts and definitions (Cohen and Hegarty, 2012).

It is important to use planetarium in the education of concepts that are difficult to achieve in science subjects, actually perceived as concrete but abstract. It is thought that it will be easier to learn these difficult-to-reach concepts with new knowledge of the students and through the activities carried out in the planetarium. Through the planetarium activities, students have studied concrete models of the concepts and achievements of the Solar System and beyond, and acquired a three-dimensional

cinematic vision. As a result of these activities, it is important to determine the academic achievement status of the students and the ability to think in three dimensions. It is also important for the determination of students' views on these activities in terms of determining the positive and negative aspects of implementation. Research has shown that planetarium activities are provided academic achievement, high-level thinking skills and to make students think visually and spatially (Bodur and Yıldırım, 2018, Özcan and Yılmaz, 2018). Apart from these investigations, no study has been found on the effect of planetarium activities on the student's three-dimensional thinking skills. Therefore, it was tried to learn the effects of the planetarium activities on the three dimensional thinking skills of the students. In addition to this, it is aimed to determine students' thoughts about planetarium and the effect of planetarium activities on academic achievement.

1.1. The purpose of research

The purpose of this research is determination of the effect of the activities of the planetarium on students' views, three-dimensional thinking skills and academic achievement**.** The following problems have been sought solved for this purpose:

- Do the planetarium activities have any impact on the students?
  a) What are the students' thoughts about the planetarium?
  b) At what level are the students' ability to think in three dimensions towards objects that are difficult to reach and large?
  c) Is there a meaningful difference between the academic achievements of the students before and after the implementation?

1.2. Limitations of research

Research is limited to a village school two class of total 32 students. Research is limited only to activities on one of the planetarium. The study uncovers only student views, three dimensions skills and academic achievements.

2. Method

Mixed method was used in the research. Since the qualitative data are weighted and supported by quantitative data, the embedded pattern is preferred (Cresswell, 2013, Yildirim and Simsek, 2013). In addition, a single group pretest-posttest quasi-experimental design was used in quantitative methods (Çepni, 2010). The program used in the research is given in Table 1.

Table 1: Program framework plan applied in the research

Order	Activity name	Created events	Duration
A	Preparation	19 Mayıs University planetarium was contacted and an appointment was made. Presentations were prepared with the expert. Preliminary application of achievement test was done.	1 day

B	Start	I went to the planetarium from school.	2 lesson
1	Planetarium tour	The planetarium in the university has been visited in conjunction with the introduction of the specialist.	1 lesson
2	Examination of 3 dimensional models	Visuals and three-dimensional materials related to celestial objects have been examined.	2 lesson
3	Presentations	Presentation of the topics with the help of projection was made by the expert.	2 lesson
a	Stars	Stars have been presented.	
b	Solar System	Solar System presentation was made.	
c	Planets	The planets were presented.	
d	Earth and satellite	Earth and satellite presentations were made.	
4	Cinevision	A three-dimensional documentary about the Solar System and beyond has been filmed on the global screen.	1 lesson
C	Evaluation	The final application of the achievement test, a fully structured interview form, and a three-dimensional thinking skill form were applied.	2 lesson
Note: There was a break between the presentations.			

The three-stage work plan is shown in Table 1. Preparation and planning were done in the first stage, activities were carried out in the second stage and evaluation was made in the last stage. The activities were took ten lessons in three different days (one lesson is 40 minutes).

2.1. Sampling

Homogeneous sampling has been used since the student group that has gained the achievements of a certain subject was selected in the research (Yıldırım and Şimşek, 2013). The research was carried out in the Kuskayası Middle School in Samsun. It has been found that the socioeconomic status of the students were similar in the school. A total of 32 students participated in the study, 17 in the seventh grade and 15 in the eighth grade (some students did not participate in the final implementations of the data collection tools).

2.2. Data collection tools

Both qualitative and quantitative data collection tools have been developed by the researcher in the direction of the research method and purpose with the direction of the Solar System and beyond acquisitions. The data collection tools were arranged in the direction of the expert academicians' opinions and pilot implementation. In this context, a fully structured interview form and a three-dimensional thinking skill form were prepared for qualitative data collection. An academic achievement test has been developed for the collection of quantitative data.

A. Qualitative tools*;* the fully structured interview form is designed to determine students' views on the planetarium. Three-dimensional thinking skills have been prepared by way of form acquisition. The purpose of this form is to determine how

students can mentalize the difficult and extremely large objects of the "Solar System and Beyond" topic and show the relationship between them. Size, distance and relationship were tried to be measured in the three dimensions form. The form consists of two parts. In the first part, "Solar System" and in the second, "Earth and satellite" were tried to determine the students' ability to think in three dimensions. Students are asked to draw with their names, paying attention to the distances and distances between the celestial objects in the relevant sections. In ensuring the validity of the forms, the data obtained are presented in cautions to show that the results are correct and can be transferred to similar groups. It is also indicated in the findings that the forms provide answers to the problem in the direction of the researcher's aim. The scope of the forms has been prepared in such a way that it is composed of two questions in order to collect the data to be obtained in accordance with the research objective and the opinions of the experts. In the reliability of the forms, help was obtained from a field specialist faculty member. Furthermore, in order to obtain similar results when another researcher applied to different groups, sample group characteristics were given, roles were specified, data collection and analysis were given (Merriam, 2013, Yıldırım and Şimşek, 2013).

B. Quantitative tool; the test was used to determine academic achievement before and after the application. According to the science curriculum, the Solar System and beyond, taught in the seventh grade, has a total of 9 achievements. It has been noted that the prepared questions are proportional to the number of acquisitions and are inclusive. Within the reliability study of the achievement test; As a result of the pilot application, substance difficulty indexes of between 0.29 and 0.69 with a substance discrimination index of less than 0.19 were removed from the test and some questions were corrected. The number of test substances was reduced from 22 to 18. Cronbach's Alpha value of the test was also calculated as 0.8 (Büyüköztürk, Çokluk and Köklü, 2013).

2.3. Analysis of data

A fully structured interview form was analyzed with descriptive and content analysis with the help of the Nvivo 11 program. The data obtained in the descriptive analysis are presented according to the theme, and the direct citation is generated. In addition, most repeated expressions are determined and frequency values are calculated. In content analysis, a more profound meaning is provided by concentrating on appropriate concepts and associations from collected data and citations. As a result of this analysis, appropriate concepts and themes have been determined (Glesne, 2013). Another specialist was consulted in descriptive and content analysis. Three-dimensional thinking skills form was analyzed at the level of department and dimension. Dimensions of the form: Size; express or quantify the magnitudes of the celestial objects mentioned in the sections of the form, distance; to be able to express or draw the distance values between the celestial objects asked, relationship; the relation between celestial bodies, the sorting being interpreted or interpreted as expressing or scaling the dimension ratios. In addition, three-dimensional thinking skills were assessed and analyzed at the level of form dimensions according to the criteria given in Table 2. The

correct number obtained as a result of the analysis was converted to a percentage and interpreted according to the evaluation comments in Table 3. It was helped by another science teacher to evaluate it according to the dimensions. In the analysis of academic success test, SPSS program was used. As the data of the academic achievement test showed nonparametric values, Wilcoxon signed rank test was used to determine the significance between them (Büyüköztürk, 2014). In the finding section, the students were coded in letters according to their grade level. Some parts are also supported with pictures.

Table 2: Three-dimensional thinking skill evaluation criteria

Criteria		Size	Distance	Relationship
1	If the celestial bodies have a size proportion	Yes		
2	Drawing is bad but proportion	Yes		
3	Size is not very good but distance is proportional		Yes	
4	If the drawings have a distance ratio		Yes	
5	If celestial bodies are orbited			Yes
6	If there is a size ratio between celestial bodies			Yes
7	If the order of the celestial bodies is correct			Yes

Table 2 contains the evaluation criteria of three-dimensional thinking skills formulas. It is assumed that this covers the dimension that covers the data covering these criteria. A data contains more than one size and may not contain any.

Table 3: Three-dimensional thinking skill evaluation result (%)

Order	Value range	Comment
1	%0,01 - % 33,33	Low
2	% 33, 34- % 66,66	Middle
3	% 66,67 - % 100	High

The correct numbers determined according to Table 2 and evaluated at the dimension levels were converted to percentages. It is interpreted according to the value range in Table 3. The percentage value range is divided into three equal parts: "low", "middle" and "high".

3. Findings and comment

Findings are given and commented according to the order of the research questions. Does the planetarium education have any impact on the students? This questionnaire was examined with three sub-questions.

a) What are the students' thoughts about the planetarium?

Findings obtained within the scope of this question are shown and commented below. The findings from the fully structured interview form are given below.

Table 4: Most repeated concepts and expressions

A) Most repeated expressions	**Frequency (f)**
1. I learned about the planets	8
2. I wanted to use the telescope	5
3. I learned about stars	4
B. Most repeated concepts	**Frequency (f)**
1. Planet	11
2. Black hole	5
3. Telescope	5

In Table 4, the top three most repeated concepts or expressions are indicated. Accordingly, students frequently used expressions such as "*I learned about planets*", "*I wanted to use the telescope*" and "*I learned about stars*". Also, the concepts of "*planet*", "*black hole*" and "*telescope*" are used frequently.

The themes based on the codes and categories used in the evaluation of the fully structured interview form are presented below along with their citation.

Theme 1: Thinking about planetarium

Positive thoughts; some of the positive statements of students on the planetarium as results of the activities are shown below:

"... did not expect it to be an exciting and beautiful place." (7k) ...
"We have informed our knowledge of the planets' place and their dimensions" (7h)
"... which planet is big and how small it is, and I have learned" (7g).
"Information about the universe and planets." (8b)
"Information about space (8n)."
"It turned out beautiful to me (8e)." ...

It is understood from the citations that students get "*information*" about "*dimensions*" and "*places*" such as "*universe*", "*space*", "*planets*" and planets "*size*". It has also been found that students express the planetarium as "*exciting*" and "*beautiful*". These expressions indicate that planetarium training activities are appreciated.

Negative thoughts; in addition to the above statements, there are also considerations that report negativity. Some of these statements are given below.

"... when I watched the clip I did not understand much. Because it was moving too fast" (7k).
"I needed more time to ask questions at my planetarium." (8c).
"... I wanted to look at the telescope" (7b). ...
"I would like to look at a piece that is breaking from the Moon" (7j). ...
"Black hole (I would like to get better)" (7a: 8d).
"... I wanted to use a telescope" (8k). ...

As understood from the citations, it is understood that the students "*complain*" that the "*clip*" used in the presentation is very "*fast*" and prevents them from "*understanding*". It is also indicated that some students want to use a "*telescope*" in the planetarium or to examine the "*piece*" from the Moon. In addition to these, it is stated that students want to understand "*black hole*". The telescope in the planetarium was shown to the students during the training, introduced and several applications were made. But it was not used to students because it was daytime. These expressions are negative thoughts about the planetarium activities of the students.

Reflected thoughts about misconceptions; it has been found that the analysis of the fully structured interview form also has misconceptions that are corrected outside of the positive and negative thoughts.

"... the star does not slip. In fact, the meteor, if the star was falling, the world would suffer a great deal" (7c).

"For example, when I look sky at the night, I say that the stars are shifting. Sky stone (7j)". ...

"Although all of the planets may be frozen water" (8e).

"Other planets have satires" (8g).

"I see how bright the stars are" (7g).

On the contrary it shows that the students' "*star skating*" is actually a "*meteor*" or "*sky stone*" it is understood that stars understand that they can "*harm*" if they fall into the Earth it has been determined that other than these, students have realized the possibility of "water" on other planets, "*satellites*" on other planets, and that stars can be very "*bright*".

b) At what level are the students' ability to think in three dimensions towards objects that are difficult to reach and large?

Findings and comments of this question are shown below.

Table 5: Three-dimensional thinking skills form statistical values

Chapter	Dimensions	Frequency (f)			Percent	Comment
		7th grade	8th grade	Total		
Solar system	Size	3	4	7	29,17	Low
	Distance	8	4	12	50,00	Middle
	Relationship	3	4	7	29,17	Low
	All Dimensions together (3D)	3	4	7	29,17	Low
Earth and sat	Size	10	11	21	87,50	High
	Distance	9	9	18	75,00	High
	Relationship	**7**	6	13	54,17	Middle
	All Dimensions together (3D)	**7**	6	13	54,17	Middle

In Table 5, the two-part data of the three-dimensional thinking skill form is shown. According to this, in the solar system, 29.17% of the students were in size (low), 50% in

distance (middle), 29.17% in relation (low) can be seen. It is noteworthy that in this table, it is understood that the seventh grade students draw the distance between the planets of the solar system twice as much as the eighth grade students. In Table 5, it is seen that the students in the Earth and the satellite have a size (high) of 87.50%, a distance (high) of 75%, a relation (middle) and all three dimensions (middle) of 54.17% together. Although the drawing frequencies of students in the seventh and eighth grades are close to one, it is generally understood that students are drawing more correctly in the Earth and the satellites than in the Solar System.

Chapter 1: The Solar System

The size, distance and relationship dimensions in the drawings made by students are examined in this section. Accordingly, some of the illustrations are shown below.

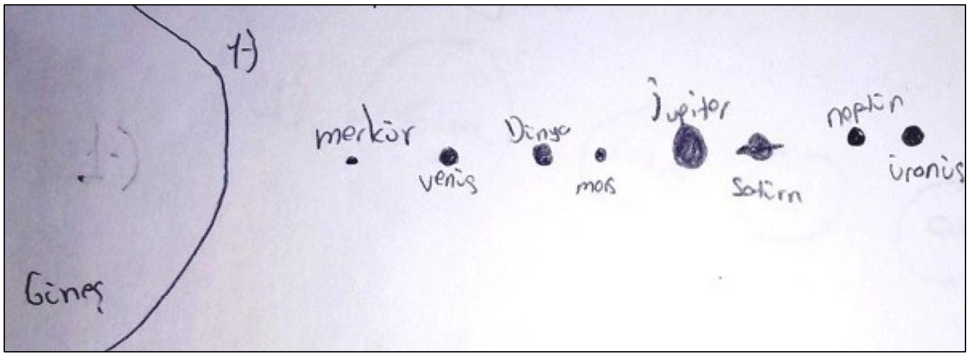

Figure 1: Drawing for 7e student's Solar System

Figure 1 represents the "size" ratio between planets in the solar system. Among the student drawings, the accuracy grade is one of the highest drawings.

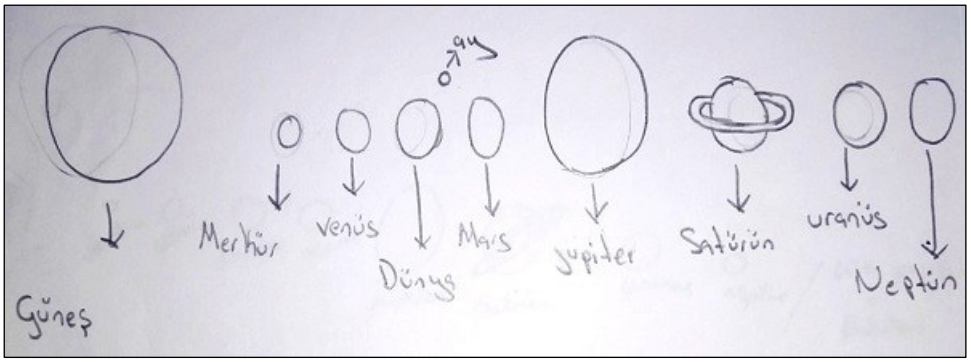

Figure 2: 8i student's drawing for Solar System

In Figure 2, although the drawing of the sun is small compared to the others, it may be an example to draw attention to the "distance" between them. The distance is one of the best drawings in terms of dimensions.

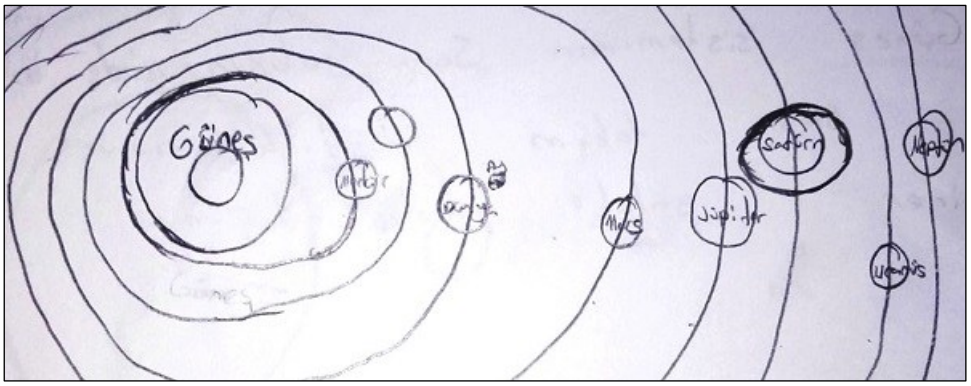

Figure 3: 8m student's drawing for the solar system

Figure 3 shows the planets of the solar system and the "relationship" between them. It is important here to emphasize that there is a relation between these celestial bodies and the extreme student of the drawing.

Chapter 2: Earth and the satellite

In the same way, the first chapter provides examples of drawings for the size, distance and relationship dimensions of the Earth and its satellite.

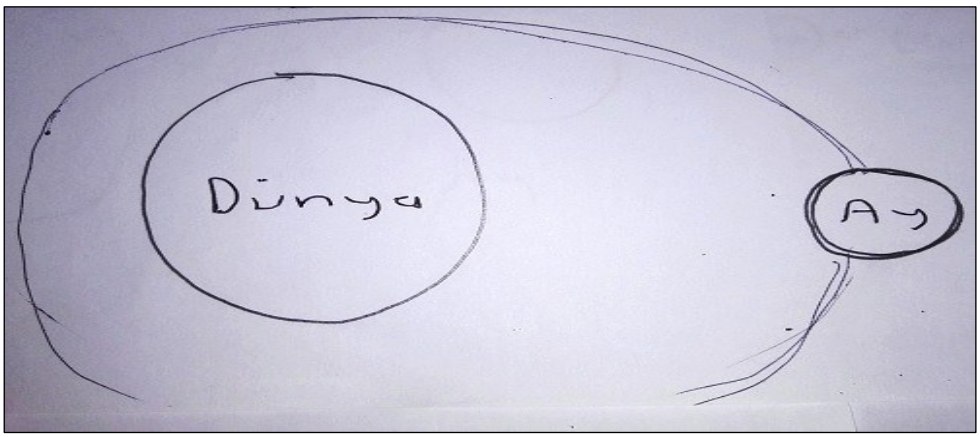

Figure 4: Drawing for 7a student's Earth and its satellite

In Figure 4, a drawing is drawn for the "size" dimension for Earth and its satellite. The relationship dimension in this picture is also shown.

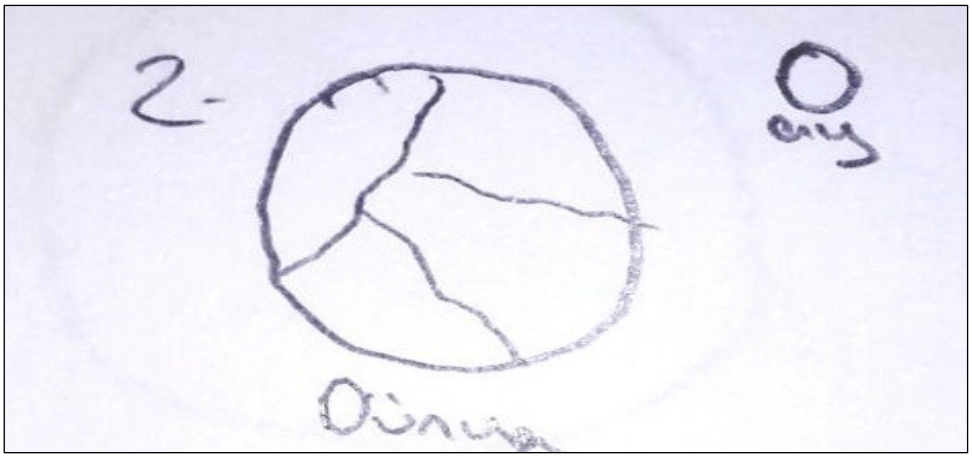

Figure 5: Drawing of 8g student for Earth and its satellite

Figure 5 draws attention to the "distance" between Earth and its satellite. The distance between Earth and Moon is proportional.

Figure 6: Drawing for 7c student's Earth and its satellite

In Figure 6, although the drawing is not good, the "relationship" between the Earth and its satellite has been tried to be shown. Arrows represent the rotation of the Moon around the Earth. Outside of these drawings, there are drawings in which students are determined to be mistaken. Below is an example of this.

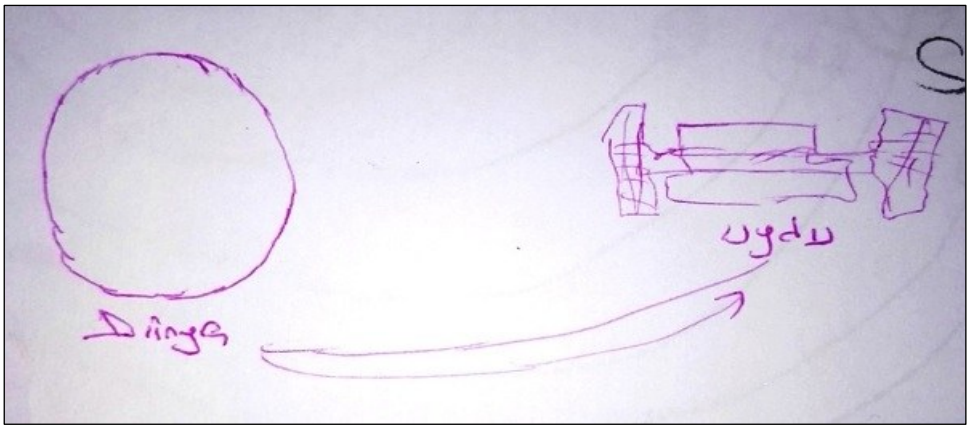

Figure 7: Drawing for 8e student's Earth and its satellite

In Figure 7, the student's understanding of Earth and its satellite is shown. Two pictures drawn in this way have been identified.

c) Is there a meaningful difference between the academic achievements of the students before and after the implementation?

Academic achievement test results before and after planetarium activities are shown below at different levels.

Table 6: Academic achievement of 7th grade Wilcoxon signed rank test values

Posttest-pretest	N	Mean ranks	Sub of ranks	Z*	p
Negative ranks	2	3,00	6		
Positive ranks	11	7,73	85	-2,77	0,006
Ties	1				
*Based on negative orders					

Table 6 shows the Wilcoxon signed rank test values of the seventh grade students before and after the activities. Accordingly, the value of "*p*" is calculated as 0.006 and it is understood that this value is smaller than 0.05.

Table 7: Academic achievement of 8th grade Wilcoxon signed rank test values

Posttest-pretest	N	Mean ranks	Sub of ranks	Z*	p
Negative ranks	2	2,50	5		
Positive ranks	10	7,30	73	-2,67	0,008
Ties	1				
*Based on negative orders					

Table 7 shows the Wilcoxon signed rank test values of the eighth grade students before and after the activities. The "*p*" value in the table is calculated as 0.008, which is less than 0.05.

4. Discussion

The data obtained as comments findings are discussed below in the light of the research questions.

a) Students' thoughts about the planetarium

Generally speaking, most of the students use positive statements as a result of planetarium activities. It is known that activities that are held outside the classroom are generally enjoyed by students. In addition, it is considered that the concepts that are difficult to reach which are effective in the virtual environment or object modeling in the planetarium. Likewise, Özcan and Yılmaz (2018) observed useful changes in astronomy concepts with the planetarium tour in his work with teacher candidates. In addition, Sontay, Tutar and Karamustafaoglu (2016) stated that out-of-school learning environments are fun and effective. Apart from these studies, Topaloğlu and Balkan Kıyıcı (2018) have found that students are more positive about daily life problems with these kinds of activities. It can also be said that some of the students have negative thoughts as a result of planetarium activities. It is thought that the reasons for learning a lot of things at one time or due to individual learning differences are thought to be this. As a matter of fact, the number of students indicating this situation is very small. Although studies on the negative aspects of planetarium activities have not been found in researches, it is generally thought that such activities should be curriculum-based (Bozdoğan, 2017).

It can be said that planetarium activities have an effect on students' misconceptions. Although it is not determined according to the purpose of the research, it is understood that the students are in some delusions. It has been found that some of the students in the study have some misinformation due to traditional knowledge and belief. It is thought that traditional views such as "no water on another planet" or "falling a star, make a wish" are influential in society. Planetarium activities have been found to eliminate these misconceptions in students. Similarly, Turks and Kalkan (2015) determined that planetarium activities were effective in determining and eliminating students' misconceptions in their planetarium activities. Apart from the above findings, it has been determined that very few students who participated in the survey perceive the concept of "satellite" as artificial satellite. For this reason, it is thought that natural and artificial satellite difference is missed.

b) Students' ability to think in three dimensions

In terms of three-dimensional thinking skills, it can be said that students are generally not good at the solar system. It can be said that the ability to think three-dimensionally in the Solar System is "low" due to the fact that the percentages are usually below 50% when viewed. It can be said that in the world and the satellites, students generally performed well. This is why the number of planets in the solar system is high. As a matter of fact, in the Earth and the satellite the students have drawn only two celestial bodies. When the percentage values are examined, it is shown that the students who are over 50% generally have better ability to think three dimensions in the Earth and the satellite. Although it shows a "high" value in size and distance dimensions, it is

understood that it is a "middle" value in relation and three dimensions in general. Planetarium activities are thought to be effective in improving three-dimensional thinking skills (Türk and Kalkan, 2015). In addition, according to Repenning et al. (2014) and Tüzün et al. (2016) studies, three-dimensional materials made with computer software have an effect on three-dimensional thinking skills. As a matter of fact, the three-dimensional cinematic representation is an example of this. In addition to these studies, Ertaş Kılıç and Şen (2014) found that such activities outside the school developed the student's high-level thinking skills positively.

c) Change in the academic achievement of the students

The analysis shows that the "p" value of the Wilcoxon signed rank test of both the seventh and eighth grade students is less than 0.05. This value indicates that there is a significant difference between before and after application. In other words, there was a significant increase in the level of knowledge as a result of the planetarium activities. It can be said that the planetarium activities increased the academic achievement of the students. Similarly, Chen et al. (2007) have found that virtual materials about our Earth are effective in acquiring subject concepts. In addition, Gülen and Demirkuş (2014) found that virtual materials increased student achievement. Such studies are similar to the effect of the cinematic demonstration used in practice. In addition to these studies, Bodur and Yıldırım (2018) found that out-of-class activities increased academic achievement. It is considered that the subjects and concepts are learned better because the level of student attention and motivation is generally high in the activities conducted outside the classroom. Therefore, it can be said that the planetarium activities increased the academic achievement of the students.

5. Results and suggestions

In general, it has been determined that the majority of students are using positive expressions as a result of planetarium activities, but they are some negative thoughts. It is also understood that planetarium activities are an influence on students' misconceptions. In general, because of the high number of positive opinions, the course of the “Solar System and Beyond” in the planetarium will be welcomed positively by the students.

It has been determined that the ability of students to think in three dimensions in terms of size, distance and relationship dimensions between the Solar System and the planets in this system is low. However, it has been found that the ability of students to think in three dimensions in the Earth and the satellite of the same students is high in size and distance, and in relationship and general three dimensions are middle. Planetarium activities can be used in the development of the three-dimensional thinking skills of students in the “Solar System and Beyond” unit.

It has been discovered that activities in the planetarium have increase academic achievement at both the seventh and eighth grade levels. Planetarium activities are positively affecting the academic achievement of students in the “Solar System and Beyond” unit.

5.1. Suggestions

It is thought that the activities of the planetarium will be effective in teaching some concepts that are difficult to reach. It is also suggested that planetarium activities may be used to prevent misconception or to eliminate misconceptions.

Information on existing facilities and activities should be provided so that students do not have excessive expectations before educational activities such as planetarium.

By doing an objective modeling, the percentage of three-dimensional thinking skills towards the Solar System can be increased.

Differences in natural and artificial satellites should be noted when the satellite of our world are presented.

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About the Author

Studded on Science education, Child development, Virtual material, Concept education.

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