

Astronomy Education for Preschool Children: Exploring the Sky

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Abstract

The purpose of this study was to examine the effectiveness of astronomy activities in science education with preschool children through semi-structured interviews. The interviews were conducted with the children before and after the implementation of the activities. Five activities about astronomy were conducted for five weeks in practice. A total of 15 preschool children (seven boys and eight girls) in the age range from 60 to 72 months participated in the study. Semi-structured interviews were individually conducted, digitally recorded, transcribed, and analyzed by the researchers of the study. The related data were collected by semi-structured interviews prepared by the researchers of the study. It was revealed that the preschool children were curious about the "Discovery of the Sky" subject. They were interested and enthusiastic to learn the subject matter, and they were positively affected by the practices. It has been concluded that new concepts related to the subject of "Discovery of the Sky" have developed by using different methods and techniques.

Keywords: Basic Astronomy Concepts, Astronomy Education, Preschool Education

Introduction

Percy (1998) claimed that there are many reasons for astronomy to be a part of the education system and culture. Astronomy is deeply rooted in the history of almost every society as a result of its practical applications and philosophical effects. Astronomy still has daily practices for long-term problems, such as timekeeping, seasons, maritime, and climate, as well as climate change and biological evolution. It not only contributes to the development of physics and other sciences but also an important and exciting science in itself. It is about the stars, the planets, and life itself. It shows our place in time and space, as well as our kinship with other people and species on the Earth. It reveals a wide, diverse, and beautiful universe. It fosters curiosity, imagination, and a sense of shared discovery. It also provides a pleasant hobby for astronomers, casual sky watchers, or millions of people. In the school context, it shows an alternative approach to the "scientific method". It can attract young people and increase public attention to study science and engineering and increase the understanding of science and technology that is important in all developed and developing countries.

Astronomy has been one of the oldest sciences for centuries and considered an interdisciplinary science examining the structure and motion of planets and is associated with a variety of developing sciences (Düşkün, 2011). As the study of Erentay and Erdoğan (2009) revealed that children are interested in scientific concepts from an early age. They first begin to see and recognize these concepts in their environment. For a child in the preschool period, what they think and observe is important for concept development. Early childhood is a period in which children gain basic concepts and scientific process skills through their experiences. Children who are curious about the developmental period often ask questions and do research to explore the environment they live in. Children learn faster in environments where they can observe and arouse their curiosity (Erentay & Erdoğan, 2009). The ac-

tion plans prepared to help students learn basic astronomy concepts were found useful and increased students' curiosity and learning about the subject (Yılmaz, 2014).

Astronomy subjects have been one of the popular topics in the school curriculum for decades (Lelliott & Rollnick, 2010). It is seen that they have been used effectively to endear the course to the students and direct them towards science (Tunca, 2002). Interpretation of knowledge and gaining scientific process skills in the preschool period are provided by science education (Hamurcu, 2003). This period is of great importance in terms of the understanding of abstract concepts and facilitating the learning of science subjects (Uyanık-Balat & Önkol, 2013). Some of the subjects included in preschool science education are our bodies, our health, food, animals, plants, (non)living beings, the Earth, and space (Alabay, 2013). Sun, planets, and stars subjects are impressive for children. Children in this period are curious and very observant of the characteristics, movements, and physical appearance of the planets. Young children are interested in day and night events and the sky. This interest leads children to make observations of celestial bodies and events in their daily lives (Kallery, 2011). Children's desire to explore is the basis for scientific sensitivity. Many concepts, including mathematics and scientific terms, begin to be acquired in the preschool period.

Children who make observations to understand the world ask questions and do research to find answers to the questions. They want to access a lot of information about the Earth, environment, space, plants, animals, soil, and water from the moment they are born. In this period, families and educators, guiding the children in curiosity, have great responsibilities. Parents provide the first scientific experience of children. Adults can support children's scientific process skills by helping them understand the world. Therefore, especially considering that for children, the years from three to six are a curiosity period, descriptive answers should be given, and their entrepreneurship and curiosity feelings should

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be supported by adults' being more sensitive to the questions that children ask during this period (Ceylan, Gözün-Kahraman, & Ülker, 2015). The studies depicted that astronomy activities develop students' curiosity and exploratory feelings and direct them more towards science (Tunca, 2002). Some claimed that the world and planets are the subjects that children want to learn and wonder most about (Laçin & Şimşek, 2007). Additionally, The European Astronomical Union defended that astronomy education should begin at an early age and that astronomy-related terms should be taught to children (Taşcan & Ünal, 2015).

Concepts of children's structure of the Earth have long been the focus of attention. Young children can record weather events, measure the rain, follow the direction of the wind, and notice the effects of it. They can simply explore the surface of the world using sand and water games (Balat, 2011). Most studies indicated that children focus on understanding the shape of the Earth, the day and night cycle, seasons and moon concepts (Saçkes, 2016). Saçkes and Korkmaz (2015) examined preschool children's conceptual understandings of the shape of the Earth and the characteristics of the cognitive representations they constructed. Their findings indicated that almost all of the children answered the question about the shape of the world as a round form or circle. When the children were asked to make the shape of the world from play dough, they generally formed globular, oval, or circle Earth models. When they were asked to draw the shape of the world, half of them produced circular drawings that included people; and some of them made drawings representing the sphere. Nearly half of the children answered the question of what was on the Earth, and the answer was space, planets, and other celestial bodies. Some of them answered clouds and airplanes, and the rest of the children answered houses and people. Kampeza (2006) indicated that although children are aware of the Earth's shape and that of the planets, the relationship between shape, rotation, and the day/night cycle is unclear. There are studies showing that preschool children have alternative concepts for the phenomena they observe, such as day and night cycles. Therefore, learning the basic concepts of astronomy at school can help children understand certain phenomena that constitute an important part of their daily lives. It can also contribute to the development of scientific thinking (Kampeza & Ravanis, 2006). Lelliott and Rollnick (2010) stated that while the conceptions about the Earth and the day-night cycle are relatively well comprehended by older students, the phases of the Moon, the seasons, and gravity are the concepts that most people find difficult to understand and explain.

Trumper (2006) stated that learning astronomy requires abstraction skills and a comprehensive understanding of the concepts of space and time, or, alternatively, it requires teaching pathways that explain phenomena as concrete as possible. According to Özsoy (2012), children have difficulty understanding the shape of the earth and various misconceptions regarding its shape. She also declared that cartoons, storybooks, and daily life experiences were the reasons for children's misconceptions. Kurnaz (2012) focused on students' understanding of the concepts of sun, Earth, moon, star, planet, and natural satellite and showed that primary and secondary school students have difficulty in understanding and visualizing these concepts. Not only primary and secondary school students but also preservice science teachers have alternative ideas about some astronomy concepts, such as stars, polar star, planets, moon, Earth, sun, and black hole (Bozdemir, Çevik, Helvacı, & Kurnaz, 2018). Kurnaz and Değermenci (2011) indicated that regardless of their grade level, students could not match the concepts of astronomy and their characteristics correctly and that the answers given for astronomy concepts and examples were inconsistent. They also concluded that students have similar misconceptions at all grade levels and that they construct different perceptions for their examples with the given concepts. The researchers also stated that

there might be an inadequate learning environment at the root of the problem.

In Washington state, early learning and development guidelines (2012), the importance of science in the preschool curriculum was emphasized for better preparation of students with the skills they need for future learning. According to this guideline, preschool children may make observations and ask questions, observe patterns in nature, such as shapes of clouds, phases of the moon, be more observant of the environment including observing shadows and changes in the position of the sun, start to understand systems (e.g., solar system, digestive system), identify individual parts and how they work together. Similar to the US system, the Turkish preschool curriculum has the following statements included in the 60–72 months of cognitive development of children: Preschool children remember the details of a picture shown for a short time, say the similarities and differences between objects, and are able to say the position of objects containing an array. Consequently, the introduction of science into preschool curriculum is emphasized in preschool education. Developmental early childhood teaching practices are based on three principles, which are multi-age grouping, nongraded curricular materials, and interactive teaching (Elkind, 1989). Multi-age grouping increases diversity among young children. Ungraded curriculum materials can be used for the benefit of children with different developmental levels. Effective interactive teaching means that the teacher must have a solid understanding of both the intellectual demands of the materials and their cognitive abilities. In interactive education, a teacher is expected to act as a matchmaker between the student and the materials. Therefore, the current study is suitable for the child development age of 60–72 months owing to the content of the activities, applicability to different age groups not limited by the curricula and including interactive activities.

In science education applications, activities that support the creativity of children by taking into consideration the developmental characteristics and that develop the scientific process skills should be included. In the current study, the subject of space in the preschool period was chosen since it is a subject in the scope of science and nature activities. It is important that the sun, the world, the planets, and the sky, in general, are among the subjects that interest children. In the light of the literature findings, the concepts of astronomy that children frequently encounter and ponder in their daily lives are discussed in this study. This study aimed to engage preschool children with astronomy-related activities and determine, through semi-structured interviews, the effectiveness of these activities.

Methodology

The study used phenomenology, one of the qualitative research methods. In phenomenological studies, researchers attempt to form the essence of the participants' experiences (Creswell, 2013). Semi-structured interviews were conducted with preschool students to learn their thoughts and experiences. According to Gay and Airasian (2000), interviews allow researchers to obtain important data that cannot be obtained from observation. Interviews can explore and probe participants' responses to gather more in-depth data about their experiences and feelings. They can examine attitudes, interests, feelings, concerns, and values more easily than by using observations.

Study Group

This study was conducted in a private school in city center. This study group was selected by the convenience sampling method. The students were planned to participate in space activities during the space week between October 4 and 10, before this study. A total of 15 preschool children participated

Table 1. *Solar System Activity Plan*

Name of the Activity	Solar System	
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Activity Type	Science-Art-Group Activity	
Teaching Methods	Question-Answer, Demonstration	
Teaching Techniques	Brainstorming	
Materials	Planet video, eight balloons covered with waste newspapers, handmade papers, various decorative materials, glue, colored finger paints	
Age Group	60–72 months old	
Development Areas		
Gains	Cognitive Development	Students should be able to: - say the name of the planets. - tell the planet where they live. - sort the first four planets according to their distance to the sun. - tell the sizes of the planets. - compare planets according to their sizes. - understand what the solar system is.
	Linguistic Development	Students should be able to: - tell about the planets. - ask questions about planets.
	Motor Development	Students should be able to - paint newspaper-covered balloons according to instructions. - arrange them side by side according to their sizes.
	Social-Emotional Development	Students should be able to work as a team by sharing materials.

in the study (age range 60 to 72 months), including seven boys and eight girls attending a private preschool in 2018–2019 academic years. This group of students was private school students, that is, they came from families with a high socio-economic background. All students participating in the study received kindergarten education when they were between three and five years old. During this course, the children raised many questions about space and planets.

Data Collection Method

Semi-structured interviews were conducted with the preschool children before and after the implementation of the space-related activities. Students were asked questions, such as “What do you know about space?”, “What are the words/terms you know about space?”, “Have you watched a movie or documentary about space?”, and “In your family, are there any books about this subject that deal with space?”. The results of the interviews are the answers that arose during the conversation about the astronomy-related activities. The reason why this study used the interview method is that the average age of the children is very low, and this method is suitable to provide deep information about students’ way of thinking.

Preparation of Activities

In this study, planned activities and materials to be used for astronomy in science education for preschool the children were prepared considering the gains in Table 1. In the preparation of the activities, the following explanation regarding the science made by the Ministry of National Education (2013) was taken into consideration: “Science activities should have the characteristics of directing children to question, draw attention to, observe, examine, and explore the concepts of science”. The names of the activities were “Solar System”, “Rocket Making”, “Space 4D Virtual Reality”, “My Dream Planet”, and “Moon Walking”. “Moon walking” is an activity that children joined into with their families. The first week of activity is given in Table 1. The children were interviewed before deciding on the scope of the content. In the preliminary interview with them, the activities were planned, considering their answers. The reason why rocket production and moon walk activity was especially chosen was that these age-group children mentioned that

they wanted to be astronauts, and they were very curious about their astronaut lives. In the preparation of the Space 4D event, the technological curiosity of today’s children was considered.

Data Analysis

Semi-structured interviews were conducted with a total of fifteen students. Each interview was conducted individually and lasted about 20 minutes. All interviews were audio-taped and transcribed later. In the analysis of the data, a descriptive analysis was implemented. Researchers first analyzed and coded the astronomy data. These codes were collected under appropriate themes after coding. Descriptive statistics provided frequency tables and the distribution of the variables. For reliability analysis, 20% of the data were analyzed by independent researchers (science education specialists). Thereafter, the reliability value was calculated as .89 according to Miles and Huberman (1994) consensus disagreement formula.

Results

In this study, 60–72-month-old children were asked some questions, such as “What do you know about space?”, “What are the words/terms you know about space?”, “Have you watched a movie or documentary about space?”, and “In your family, are there any books about this issue that deal with space?” during interviews. The children’s responses to these questions are summarized in Table 2.

Table 2 shows a remarkable difference between the answers of the children participating in the activities in the preliminary interviews and their answers in the final interviews. In the preliminary interviews, the children generally talked about the concepts of planet, space, astronaut, the Sun, Earth, Moon, and stars. After the astronomy practices, it was found that the children mentioned the concept of the Solar System and expressed the number of planets correctly. While the children used only the term of astronaut before the application, they used expressions about astronaut costume and an astronaut’s life after learning about the implications. One of the noteworthy elements of Table 2 is that although the students mentioned the Sun as a planet before the application, they mentioned the Sun as a star after the

Table 2. Pre- and Post-Interview Answers of Preschool Children

Number of Answers	Pre-Interview	Post-Interview
1	Astronauts sewed the flag. There are meteor showers.	I learned about astronauts. I've learned that there are many spacecraft. I learned that there are big and small planets. There are eight planets in space.
2	There are stars in space. There is Earth.	I found out there are other planets outside the world. Uranus, Neptune, and Mars. If we're going into space, we need to wear space costumes. Saturn, the planet that did not fall when we threw it into the sea. The sun is a star.
3	There are stars in space. There are moon and astronauts.	Those without special clothes can't stay there. He can't live on the sun because it's hot.
4	In space, there are Jupiter and Earth.	There is no gravity in space. Anything can jump. They wear masks to breathe. On their way, they see Neptune, the Sun, and the Moon.
5	The meteors fall from space. There are stars. Planets, the Sun and the Earth exist.	Rocket, planet, stars. Pluto is a dwarf planet.
6	The meteor falls from space. There are stars. Planets, sun, and Earth exist.	I learned about stars, Uranus, the moon and astronauts. I learned about the space rocket and the aliens. I've learned all the planets in space. Jupiter is the largest planet.
7	Stars are in space. Uranus, astronauts and Neptune.	I learned the planets. Pluto is a dwarf planet. There are eight planets. The ringed planet is called Saturn. Jupiter is the largest planet. Astronauts can go into space and collect moon fragments, and then examine them.
8	There is a space rocket in space. There are round stars and the moon.	We've learned that meteors are different and there is no life in space... We've learned what the planets are. There are eight planets, such as Jupiter, Earth, Uranus, and Neptune. Walking on the Moon is difficult because there is no gravity on it.
9	We live on Earth. We can go into space. We can go to Neptune and the moon.	I learned that Uranus and Neptune looked blue in the distance. The earth is third and is our planet. Everywhere on the earth is full of living things. Jupiter is the largest planet. The sun is a very hot star. I love the planets.
10	We live on Earth. We could go anywhere. We can even go to space.	I learned that some of the planets are ringed and blue. There is only life on earth among planets. For example, the earth revolves around the sun and itself. The moon is our satellite; in fact, it does not shine but reflects the light of the sun to us.
11	We go to Jupiter in space. We live on Earth. There are large telescopes in space.	Moon, I've known it for a long time. There are winds inside Jupiter. I have learned about the dwarf planet, Pluto.
12	Meteors fall. There are astronauts in space. There is Earth.	The sun is very hot and there is no air in space. That's why astronauts have an air tube. Astronauts drink their drinks with a straw.
13	Counting the Sun, there are 10 planets. Astronauts cannot stay in space for a day or two.	There used to be nine planets in space. Now, there are eight planets because Pluto is so small that scientists have removed it from being a planet. The sun is not a planet, it is a star.
14	In space, there are stars, meteorites, and Earth.	The planet Mars is also known as the red planet. We're in the Solar System. There are Neptune, Mars, Mercury, and Jupiter. When the sun is seen from a distance, it looks larger than other stars, but in fact, they are of the same size.
15	There are planets and astronauts in space. There are aerolites in space.	There are eight planets. I learned that Mercury is the closest planet to the sun, and Venus is the brightest planet because we have the planet Saturn ring that does not fall when we throw it into the sea. The sun, which is our star, warms us. The earth, which we live on, is in third place.

Table 3. Frequency Distribution of Astronomy Terms during Pre- and Post-Interviews

Astronomy Terms	Pre-Interview		Post-Interview	
	<i>f</i>	%	<i>f</i>	%
Sun	15	100	15	100
Star	14	93	15	100
Meteorite	10	66	4	26
Earth	8	53	15	100
Mars	5	33	15	100
Jupiter	1	6	15	100
Mercury	-	-	15	100
Venus	-	-	15	100
Saturn	-	-	15	100
Neptune	-	-	15	100
Uranus	-	-	15	100

practicing activities. After activity implications, they said that the planet that we live on is ranked third in proximity to the Sun, and they used the cyclic planet term for Saturn. They talked about the physical properties of the planets; for example, they stated that “Mars is the red planet”, “Jupiter is the largest planet”, and “Pluto is a dwarf planet”. They also stated that the “Moon is a satellite of the Earth”, and space is an environment of gravity. They paid attention to the position of the planets in the solar system relative to the Sun, and stated that Mercury is the planet closest to the Sun.

Table 3 presents the frequency and percentage of the terms used by the students during the preliminary and final interviews.

Table 3 shows that while the children could express the names of three of the planets before the practices, all the children could express the names of all the planets after the practices and paid attention to their sizes. Additionally, it was found that the majority of the children knew the order of the planets with respect to the proximity of the latter to the sun; this ability was among the top four. Furthermore, in both interviews, the children were posed the following questions: “Do you want to go into space?” and “Are you curious about space?”, and everyone answered them in the affirmative. In the last interview, ten children stated, after the activities, that they were more curious about space and wanted to go to space.

Discussion and Conclusion

The results of the study indicated that although the children generally talked about the concepts of planet, space, astronaut, the Sun, the Earth, the Moon and stars in preliminary interviews, they mentioned the concept of the Solar System and expressed the number of planets after astronomy practices. Also, they used the term of astronaut before the application, but after the practice, they gave details about astronaut life. The idea that “the Sun is a planet” has been replaced by “the Sun is a star”. In the post interviews, it was determined that preschool students used the term meteor less than before their engaging activities. This may be because astronomy activities are not directly related to the concept of a meteor, and hence the decrease in the frequency of its use. Furthermore, the children were able to sort the planets according to their distance from the Sun and give their properties by analogies. For instance, they would state Mars as a red planet, Jupiter as the largest planet, and Pluto as a dwarf planet. Likewise, Küçük and Şimşek (2017) specified that children are very curious about space and define it as a big void. The children stated that there were the Sun, the Moon, the Earth, stars, and planets in space. There were also some children who learned the names of the planets and some characteristic properties of them. For instance, some of the preschool children learned that the Earth is round, the Sun is a star, the name of almost all the planets, the temperature of the planets according to their proximity of the latter to the Sun, that there is a storm on some planets, Pluto is a dwarf planet, astronauts go to space, astronauts go to space with a space rocket.

The present study reveals that preschool children aged 60–72 months participated in the activities with interest and enthusiasm. When the developmental characteristics of the children in cognitive, linguistic, motor, and socio-emotional domains were examined, the activities they practiced helped them to use their scientific process skills. The preliminary and final interviews results reveal that

children learned many of the concepts of astronomy better through the activities implemented. It has been observed that these activities positively affected their motivation

and attitude towards astronomy, and thus there was an increase in student participation in each activity. Besides, it has been observed that the children could learn many concepts easily through practices and were willing to work after designing concepts in this design. Studies indicated that since preschool students do not take courses in astronomy at school, their ideas are based on their own environmental perceptions (Hannust & Kikas, 2007). Moreover, preschool students have some misconceptions about day-night, seasons, and moon concepts. During the interviews, preschool students stated that they learned these concepts from their families, daily experiences, and observations (Küçüközer & Bostan, 2010a).

Ampartzaki and Kalogiannakis (2016) mentioned that learning should encourage young minds, engage, and excite them so that they will accept the new information presented and develop a lifelong interest in astronomy. The relation between the real world and symbolic representation is critical to understanding astronomical phenomena. Dunlop (1998) also explored the ideas that children who visited Auckland Observatory and the Stardome Planetarium had about the Earth, the Moon, and the Sun. Several ideas, unlike other studies, were reported. For instance, two children drew eight orbits traveling around the Moon in a day and the Sun at night for the Earth. Only one child out of 67 who participated in the study proposed the concept of day and night caused by the Sun.

Campos, Pessanha, and Jorge (2011) stated that the augmented reality practices applied in the preschool period increased curiosity in children and supported cooperative learning. It was also determined that children who could not see the planets exactly with the naked eye but may have heard of them were able to express better the sizes of the planets after the practices. The children stated that the concepts in astronomy were represented in three dimensions in the best way with augmented reality applications and they were very realistic. It is thought that a three-dimensional image contributes to the retention of knowledge of a child in the preschool period. Likewise, Hsieh and Lee (2008) stated that the Augmented Reality English Learning System (ARELS) designed for preschool children in a preschool consists of fun and effective participation of children. Thanks to the combination of virtual objects and reality scenes, children can use ARELS to learn English words by playing. Each augmented reality (AR) English word card corresponds to each 3D virtual object, respectively. They used the alphabet ‘E’ Earth word as an example. Children could turn and move the AR English word card around in any direction arbitrarily. In this way, they could learn an English word by seeing its 3D image.

When the preschool education program of the Turkish Ministry of National Education in 2013 was examined, the 5th educational gain involved children observing objects or assets. It was found that those children achieved this cognitive gain by realizing the sizes of the planets in the design of the planetary activity. In the 9th gain, it was stated that children could “sort objects or assets according to their characteristics”. When the responses of the children were examined, their rankings were observed by comparing the planets according to their sizes. In relation to the cognitive development of children, it was stated that children could “establish a cause-and-effect relationship”. The child was expected to ask open-ended questions to express their thoughts about the outcome of any event or situation, to find possible causes of the situation. They stated that the Moon was the satellite of the Earth. In the present study, all activities carried out within this scope were carried out considering these gains.

Küçüközer and Bostan (2010b) determined that preschool students have various ideas about the center of the universe, the position of the stars during the day and the brightest star at night. According to interview results, they believed that the Moon was the brightest star at night and that the Sun was in the center of the universe. Since these children had not received any prior instruction on astronomical subjects, their ideas were shaped by their observations and daily life experiences. Students generally do not have a clear idea of the Sun/Earth/Moon model and lack some concepts to build it. They also find it difficult to express themselves in diagrams. Very strong incentives are needed to draw attention to the written text as well as special instructions from the teacher if learning is to take place (Pena & Gil-Quilez, 2001). Studies also demonstrated that not only preschool students, but also preschool teachers have alternative ideas, including definition, motion, brightness, structure, and shape for the concepts of stars, planets, the Earth, the Sun, and the Moon (Saka, 2018). In this context, the results of the study can be useful in revealing preschool students' ideas about the basic concepts of astronomy.

Recommendations

Interviews with working groups from different cultures can be repeated to improve the reliability of the study. Different methods, such as observation and drawings, can be used to collect the data. Also, parents can be included in the study to find out how they can direct their children's interest in science.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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