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Small Astronomers

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Abstract

Children are inherently curious about science subjects, and astronomy offers an interesting theme within these subjects. In this context it is thought that understanding the preschool child's knowledge about astronomy may be a starting point for astronomy education at a young age. The purpose of this research is to investigate children's knowledge about the basic astronomy concepts. The study was undertaken with 103 children aged 4-6 years, attending various lower and upper socioeconomic level public and private preschools. The data of the study were collected using the AKTPC test created by the researchers, and analyzed using ANOVA and T-test. At the end of study, age and gender variables didn't lead to a significiant difference in terms of the astronomy knowledge of the children, whereas there was a significiant difference in favor of children at the upper socioeconomic level. Also, it was seen that children were aware of basic astronomy concepts, and they used their ability in terms of the scientific process to explain astronomic events.

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1. Introduction

Nowadays, although the importance of astronomy education is only recently understood, Bailey and Slater (2003) identified astronomy as one of the oldest known sciences. Janke and Pella (1972) emphisized that one quarter of 52 important physical science subjects that have been developed were about astronomy (as cited in Bailey and Slater, 2003). It was thought that astronomy, which is closely related to daily life, had also a big effect on the interests of children and students. Pena and Quilez (2001) claimed that the increased interest in the updated subjects of astronomy involving stars, comets, satellites and space in the mass media, motivated students from different educational levels to study astronomy. Yaşar and Duban (2009) reported that children behaved as scientists in terms of the way they understand what is happening on their environment and realize the truths of nature, and how they observe and explain the conclusions to their observations. Khishfe (2008) underlined that scientific knowledge could be acquired experimentally that the information produced is subjective – namely, it is related to the background knowledge of self - and that imagination and creativity are important in the construction of knowledge where social interacitivity occurs. With regard to the ability to solve problems by means of imagination, Tuğrul (2006) mentioned that the children of the 21th Century were expected to be creative, geniune, decision makers, and take responsibility as both owners and solvers of problems.

The curiosity of children with regard to the astronomical events they observe, encourages them to learn and to form cases of problems that are new to them and need to be solved in their minds. The evaluation of the level of basic astronomical knowledge and the needs of children will contribute to the preparation of more effective learning environments. From this point of view, this study aims to investigate the knowledge levels of preschool children by comparing the Sun, the Moon, the day-night cycle and celestial bodies. It was thought that the study would contribute to the evaluation of basic astronomic knowledge levels and the learning needs of preschool children and for the creation of a more effective learning environment for this age group.

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2. Methodology

2.1. Sample

103 children aged between 4 and 6 years, attending preschool or private kindergarten, were included in the study. Among the sample group, 50.49% were from a lower socioeconomic level (SEL) environment and were attending village preschools in Kahramanmaraş, while 49.51% were enrolled in private preschools of an upper socioeconomic level in the city center of Ankara. The distributions of children's ages were; 17.5% were 4 years of age, 43.7% were 5 and 38.8% were 6, with 44.7% female and 55.3% male.

2.2. Research Methods and Materials

A mixed method approach involving both quantitative and qualitative data was used in the study. In order to test the subjects' knowledge of astronomy subjects, a test called Astronomy Knowledge Test for Preschool Children (AKTPC) was developed by the researchers. During the AKTPC development process, a pilot study was performed with a group of 30 children involving the suggestions of specialists in astronomy and childhood development. After redesigning or excluding test items which were seen to be nonfunctional, the AKTPC consisted of four parts and 15 questions. There were three open-ended questions about the concept of the "Sun" and one question based on drawing in the first part; four open-ended questions about the concept of the "Moon", and one question based on drawing in the second part; four open-ended questions about the "day-night cycle" concept and one question in which visual themes were used in the third part; and a question was asked about the "comparison of celestial bodies" in the fourth part.

2.3. Data management and analysis

Firstly, information about the study and the AKTPC were given to the children by the researchers, and then the children who volunteered to answer the AKTPC questions were identified. Tests were performed on each child individually by the researchers. Each child was given approximately 10 minutes to practice the test. In terms of the evaluation of the test, it was concluded that the score for a non-answered questions would be 0; the score for answers not based on any logical and/or scientific reasons but that contained a view would be 1; and answers explained with logical and/or scientific reasons would be 2. By this scoring system, it was calculated that a child could obtain a maximum of 43 points by achieving a maximum of 12 points from the first part, a maximum of 16 points from the second part, a maximum of 12 points from the third and a maximum of 3 points from the last part, and minimum of 0 points. During the evaluation of the test, not only "absolute true and scientific knowledge" was looked for in order to gain 2 points, but also the usage of scientific course ability and scientific thinking. Accordingly, tests were scored by the researchers independently; and the most appropriate score for each child was decided after discussion and judging of all the scorings. The SPSS 16 version software package was used to analyses the data. The knowledge of the children with regard to basic astronomy concepts were evaluated by using descriptive statistical methods and the independent group T-test and ANOVA methods were used for the determination of whether or not age, gender and SEL variables had an effect on the knowledge of basic astronomy.

3. Findings and Discussion

The results of the study were composed of two parts in the form of quantitative and qualitative data. T-test and ANOVA results of the average AKTPC scores of the children involved in the study with respect to age, gender and SEL are shown in Table 1.

Table 1. T-test and ANOVA results of average AKTPC scores with respect to age, sex and SEL variables.

Groups	N	Min	Max	$\bar{x}$	%	S	p
AGE							
4	18	17	37	27.4	63.7	5.72	
5	45	7	40	24.0	55.8	7.93	.235
6	40	11	37	25.3	58.8	6.67	

SEX							
Female	46	7	40	24.6	57.2	7.55	
Male	57	8	37	25.6	59.5	6.84	.538
SEL							
Bottom	52	7	35	25.5	59.3	5.99	
Top	51	19	40	29.8	69.3	4.81	.000*
Total	103	7	40	25.1	58.4	7.15	

Table 1 indicates that the basic astronomy knowledge level of children was about 58.4% according to AKTPC. The minimum score was detected as 7 (for 5 year olds) while the maximum score was 40 (for 5 year olds). The average score for females was 24.6, and average score for males was 25.6 as shown in Table 1. It can be said that age and gender are not variables that affect basic astronomy success based on the result that there was no significant difference in terms of the mean scores between ages and genders. However, when the table is analyzed, it is seen that the mean basic astronomy success (69.3%) of upper SEL children is higher than the mean basic astronomy success (59.3%) of lower SEL children. The same difference between each of the SEL groups is also noticed in terms of minimum scores. It can be seen that the minimum AKTPC score for children in the lower SEL is 7, while in the upper SEL it is 19. According to the results of the independent group T-tests and ANOVA, success as measured by the test scores in terms of basic astronomy concept knowledge, indicated a statistically significant differentiation in favor of upper SEL children [$t(103)=8.66$, $p<.05$]. It was noted that, whereas the mean score of lower SEL children was 25.5, the mean score of upper SEL children was 29.8. This difference between the basic level of astronomy concept knowledge of the children studied is considered to originate from living habitat, diversity and abundance of stimulators, and family interactions. Table 2 shows the ANOVA results with regard to the scores for AKTPC questions related to the basic concepts of "Sun" and "Moon" with respect to age, sex and SEL variables.

Table 2. ANOVA results of success scores for AKTPC questions on "Sun" and "Moon" concepts with respect to age, sex and SEL variables

	Groups	N	Min	Max	$\bar{x}$	%	S	p		Min	Max	$\bar{x}$	%	S	p
CONCEPT OF SUN	**AGE**								CONCEPT OF MOON						
	4	18	6	11	8.44	70.3	1.38			5	15	9.83	61.4	3.11	
	5	45	1	12	7.33	61.1	2.51	.082		0	15	8.24	51.5	3.87	.290
	6	40	4	11	7.12	59.3	1.83			0	16	8.90	55.6	3.61	
	Total	103	1	12	7.45	62.1	2.13			0	16	8.78	54.9	3.66	
	SEX														
	Female	46	1	11	7.22	60.1	2.20	.329		0	16	8.44	52.8	3.66	.397
	Male	57	2	12	7.63	63.6	2.08			0	16	9.05	56.6	3.67	
	Total	103	1	12	7.45	62.1	2.13			0	16	8.78	54.9	3.66	
	SEL														
	Bottom	52	1	11	6.46	53.8	2.17	.000*		0	13	6.69	41.8	3.04	.000*
	Top	51	4	12	8.45	70.4	1.55			5	16	10.9	68.1	2.97	
	Total	103	1	12	7.44	62.0	2.13			0	16	8.78	54.9	3.66	

It is seen in Table 2 that the ratio of answering questions about the "Sun" concept is 62% with a minimum score of 1 and a maximum score of 12. While age and sex variables didn't suggest a significant difference in the ratio of answering questions related to "Sun", it was found that upper SEL (70.4%) children were at higher levels than the lower SEL ones (53.8%). This result shows that the SEL variable causes significant difference between groups with regard to the concept of "Sun" ($p<.05$).

It can be seen in Table 2 that the ratio of answering questions about the "Moon" concept is 54.9% with a minimum score of 0 and a maximum score of 16. The finding that the knowledge level of children with regard to the concept of the "Moon" is only 54.9%, is similar to the studies performed by Trundle, Atwood and Christopher (2007) on primary education children that revealed that almost half of the students had difficulties in drawing the stages of Moon or failed to draw them. In this research; while age and sex variables didn't depict a significant difference in the ratio of answering questions related to "Moon", it was found that upper SEL (61.8%) children were at higher levels than the lower SEL ones (41.8%), and SEL was found to cause a significant difference in the concept of "Moon" ($p<.05$). Apart from this, it was found that, the ratio of knowledge level for the "Sun" concept (62.0%) was higher than the ratio of knowledge level for the "Moon" concept (54.9%).

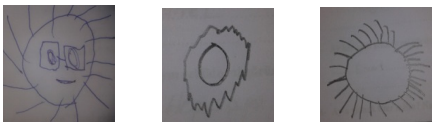
In Table 3, the ANOVA results with regard to the scores for the AKTPC questions on the "day-night cycle" and "comparison of celestial objects" concepts with respect to age, sex and SEL variables are given.

Table 3. ANOVA results of success scores for AKTPC questions on "Day-Night Cycle" and "Comparison of Celestial Bodies" concepts with respect to age, sex and SEL variables

	Groups	N	Min	Max	$\bar{x}$	%	S	p		Min	Max	$\bar{x}$	%	S	p
DAY-NIGHT CYCLE	**AGE**								COMPARISON OF CELESTIAL BODIES						
	4	18	2	10	7.61	63.4	2.62			0	3	1.50	50.0	.79	
	5	45	1	12	6.58	54.8	2.87	.113		1	3	1.87	62.3	.66	.108
	6	40	4	11	7.65	63.8	2.02			0	3	1.65	55.0	.62	
	Total	103	1	12	7.17	59.8	2.55			0	3	1.72	57.3	.68	
	SEX														
	Female	46	1	12	7.28	60.1	2.62	.703		0	3	1.70	56.7	.70	.761
	Male	57	1	11	7.08	65.0	2.52			0	3	1.74	58.0	.67	
	Total	103	1	12	7.17	59.8	2.56			0	3	1.72	57.3	.68	
	SEL														
	Bottom	52	1	10	5.79	48.3	2.47	.000*		0	3	1.58	52.7	.75	.032
	Top	51	5	12	8.59	71.6	1.75			0	3	1.86	62.0	.56	
	Total	103	1	12	7.17	59.8	2.56			0	3	1.71	57.0	.68	

In Table 3, the ratio of answering questions about the "day-night cycle" is 59.8% with a minimum score of 1 and a maximum score of 12. These results are similar to the findings of the study on "day-night cycle" with 1st, 3rd and 5th class primary education students by Vosniadou and Brewer (1994) which indicated especially that students in the first and third classes could define the configurations of Sun, Moon and earth with respect to each other, related to the formation of day-night. According to results of this research, while there wasn't a significant difference in the ratio of answering questions related to the "day-night cycle" in terms of age and sex variables, it was found that upper SEL (71.6%) children were more successful than lower SEL ones (48.3%). This result shows that the SEL variable causes a significant difference between groups for the concept of the "day-night cycle" ($p<.05$). Also, it was found that the ratio of knowledge levels for the ''day-night cycle" (59.8%) was higher than the ratio of knowledge levels for the "Moon" concept (54.9%), and lower than the ratio of knowledge levels for the "Sun" concept (62%).

It is seen in Table 3 that the ratio of answering questions about "comparison of celestial bodies" was 57% with a minimum score of 0 and a maximum score of 3. There was no significant difference in terms of age, gender and SEL variables for the questions related to "comparison of celestial bodies". Studies by Bisard, Aaron, Francek & Nelson (1994) and Trumper (2000), also reported that there was no significant difference with regard to gender in any of the age groups in terms of astronomy success (as cited in Güneş, 2010). Also, it was found that the ratio of the knowledge level for ''comparison of celestial bodies" (57%) was higher than the ratio of the knowledge level for the "Moon" concept (54.9%), and lower than the ratio of knowledge levels for the "Sun' concept (62%) and the "day-night cycle" (59.8%). Figures drawn by children in response to "Can you draw a picture of the Sun?" and " Can you draw a picture of the Moon?" in the AKTPC section related to drawings of the "Sun" and "Moon" concepts, are presented in Figure 1 and Figure 2.



4 years old 5 years old 6 years old

Figure 1. Sketches of the Sun

4 years old 5 years old 6 years old

Figure 2. Sketches of the Moon

Some of the answers to questions related to the "Sun" concept - "What would happen if the Sun didn't exist?" and "Do you want to go to the Sun? How could you go to the Sun?" - are coded according to age, gender and socioeconomic levels, and presented in Table 4. Some of the answers given to questions related to the "Moon" concept - "What would happen if the Moon didn't exist?" and "Do you want to go to the Moon? How could you go to the Moon?" - are given in Table 5; impressive answers given to the question "Does the Moon always look the same?" are in Table 6, and some of the answers given to questions related to the "day- night cycle" - "How do you think it becomes night?" and "How do you think it becomes day?" - are presented in Table 7.

Table 4. Some of the answers the children gave to the questions *"What would happen if the Sun didn't exist?"* and *"Do you want to go to the Sun? How could you travel to the Sun?"*

"What would happen if the Sun didn't exist?"	***"Do you want to go to the Sun? How could you travel to the Sun?"***
$4M_{U:}$ *"All people would freeze; the Sun heats."*	$4F_{U:}$ *"Yes, I can be an astronaut and go."*
$4F_{U:}$ *"There would be no light. The Sun gives the light to lamps. It is very important."*	$5F_{U:}$ *"Yes, I go by climbing up a long ladder."*
$4M_{L:}$ *"The World would be cold."*	$5M_{U:}$ *"Yes, because I want to measure its temperature with a thermometer. By airplane or helicopter."*
$5M_{L:}$ *"Everywhere would be cold, and we would feel very cold."*	$6F_{L:}$ *"Yes, I could if I were a bird."*
$6F_{U:}$ *"It would always be cold and plants could not grow."*	$6M_{L:}$ *"Yes, when we have floors."(like floors of a building)*
	$6M_{U:}$ *"I'd like to, by spaceship."*
	$6F_{U:}$ *"Yes, by a rocket."*
	$6F_{L:}$ "No, because it is too hot."

Legend: 4-5-6 = age, M= Male F=Female $_{L=}$Lower socioeconomic level $_{U=}$ Upper socioeconomic level

Table 5. Some of the answers the children gave to the questions *"What would happen if the Moon didn't exist?"* and *"Do you want to go to the Moon? How could you travel to the Moon?"*

"What would happen if the Moon didn't exist?"	***"Do you want to go to the Moon? How could you travel to the Moon?"***
$4F_{U}$: *"It would always be daytime, we would always be awake."*	$5F_{U}$: *"Yes, I can go on foot, it is too far but maybe I can go by taking breaks."*
$4M_{U}$: *"We wouldn't have a flag. Atatürk would be sad."*	$5F_{L}$: *"I don't want to go the Moon, I don't want to go to the Sun. If I go I'd miss my mom."*
$5M_{U}$: *"It wouldn't be dark. We couldn't make it get dark."*	$5M_{U}$: *"No, there is no water there, water flies in the sky. There is no gravity."*
$5M_{U}$: *"We couldn't grow up, we need to sleep for this."*	$6M_{L}$: *"Yes, by plane, helicopter and spaceship."*
$6F_{L}$: *"Nights would be dark, lights would be gone."*	

Legend: 4-5-6 = age, M= Male F=Female $_{L=}$Lower socioeconomic level $_{U=}$ Upper socioeconomic level

According to the answers in Table 4, it was noted that children know the Sun as a light and heat source and mostly upper SEL children use scientific words like astronaut, grade, spaceship and rocket. In Table 5, it is seen that they also consider the Moon as a source of light.

Table 6. Some of the answers the children gave to the question *"Does the Moon always look the same?"*

"Does the Moon always look the same?"
$4F_{U}$: "*Some days it looks round. We call it a full Moon. Sometimes it becomes half and is called half. We can know the cause of this if we observe it with a telescope but there is no telescope at school."*
$4F_{U}$: *"It is a baby when it first rises; I mean half, then it gets fatter as it gets older."*
$5F_{L}$: *"No, clouds sometimes cover it."*
$5F_{U}$: *"Different, sometimes it is filled sometimes half-filled. Sometimes it appears in daytime because it needs to take shape in order to fully appear at night."*
$5M_{U}$: "*No, sometimes curved, sometimes smooth. It sometimes looks round and sometimes looks like a bitten apple. I think the Earth causes this."*
$5F_{U}$: *"Sometimes full Moon, sometime half Moon. Sometime a portion of the Moon falls into space."*
$5M_{U}$: "*No, it is small at the beginning, then it gets larger, sometimes there is no Moon at all."*
$6F_{U}$: *"Sometimes it looks like a banana, and sometimes it looks round. It appears round only during Ramadan time, for blessing."*
$6F_{L}$: "*It doesn't always look the same. It is sometimes full and sometimes a half Moon."*
$6F_{U}$: *"Sometimes round, sometimes in the form of a half mouth (She points to her upper lip)."*

Legend: 4-5-6 = age, M= Male F=Female $_{L=}$Lower socioeconomic level $_{U=}$ Upper socioeconomic level

In the light of the data shown in Table 6, it can be seen that children develop alternative concepts for the Moon and also use various images for describing the stages of the Moon. These data support the idea of Piaget (1970): children have mistaken concepts about the Moon and its stages; the cause of these mistakes is the rotation of the Moon in the sky, observed by children (as cited in Trundle et al., 2007).

Table 7. Some of the answers the children gave to the questions *"How do you think it becomes night?"* and *"How do you think it becomes day?"*

"How do you think it becomes night?"	***"How do you think it becomes day?"***

$4M_U$: "*God makes it.*"	$5F_U$: "*When the Earth turns around and the Sun and the Earth are in the same direction.*"
$4F_U$: *"The space is already dark, when the Earth faces space and it becomes night."*	$5F_U$:*"The man in the Moon sleeps and the Sun wakes up."*
	$6M_U$: *"When our country faces the Sun."*
$4M_U$:*"When the Sun delivers its light to other worlds, our world becomes dark. We call this night."*	$6F_U$: "*The Moon and stars feel sleepy, the Sun comes instead to illuminate, and it takes over the duty from the Moon."*
$5F_U$: *"It occurs between the Sun and the Moon. The Sun and the Moon talk to each other, they say let's do like this. The Sun goes, the Moon comes and it becomes night."*	
$6M_U$: *"As the Earth turns around, the sunlight sometimes cannot reach us and it becomes dark."*	
$6M_L$: *"When the Sun goes down."*	

Legend: 4-5-6 = age, M= Male F=Female $_L$=Lower socioeconomic level $_U$= Upper socioeconomic level

The animistic thought noted in the answers "Between the Moon and the Sun", "They talk to each other, say that lets do like this; the Sun goes, then the Moon comes and night occurs", given to the question "How do you think it becomes night?", is parallel with the finding of Piaget (1964) that infants believe that the Moon is alive like all other movable things. They think that Moon follows them. The answer "God makes it" for the same question can be explained by White's argument (1994) that the environment and the child's family are effective when it comes to the views of children about evaluation and creation (as cited in Şimşek and Tezcan, 2008).

4. Conclusion and Implications

As a result of the study, besides finding that usually the age and gender of children are not important variables in terms of acquiring basic astronomical knowledge, it was determined that the SEL variable was important, in that upper SEL children had more information about basic astronomy concepts compared to lower SEL children. Likewise, it was found that there was no significant difference caused by age and gender variables in answering questions related to the "Sun", "Moon" and "day-night cycle" concepts, but upper SEL children were more successful than lower SEL children. It was concluded that there was no significant difference in terms of children's age, gender and SEL variables with regard to the questions related to "comparison of celestial bodies". Families and teachers of children have an important role to play in the development of basic astronomical knowledge and discovering an interest in astronomy. Families can answer questions about astronomy simply and clearly by paying attention to the scientific interest of their children, can chat to them about the sky, celestial bodies and events and can ask them to draw whatever they have observed. They can visit and investigate astronomy and meteorology museums and observatories with their child, can go hiking and give information when their children are willing to learn about the Sun, the Moon, celestial bodies and day-night cycles etc. Teachers should encourage children in order to begin a scientific course on the subject of astronomy, can ask them open-ended questions that will lead them to think, can let them watch movies, cartoons and documentaries and, in this way, can talk about these topics They can answer questions and engage in permanent learning by creating projects, and involving the children in drama, and science experiments related to astronomy and scientific activities in the classroom. Although the number of children included was limited, the study - with results that parallel the literature – is a preliminary one, leading to increased awareness of the subject. It is thought that the results can be generalized by studying a larger sample group, and these results could light the way with regard to new studies.

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