



A CROSS SECTIONAL STUDY ON THE SUCCESS OF THE PRE-SERVICE SCIENCE TEACHERS REGARDING THE MOON AND ITS MOVEMENTS

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Abstract

The objective of this study was to examine the changes in pre-service Science teachers' achievements and alternative concepts about the moves, phases and eclipses of the Moon in terms of their year of study. The study was conducted with 306 pre-service Science teachers (in their first, second, third and fourth year of study) studying at a university in the Black Sea region of Turkey. Moon Achievement Test (MAT) was used as data collection tool. One factor variance analysis (One-Way Anova) technique was used for independent groups in data analysis in order to find out whether pre-service teachers' achievements in concepts about the "Moon" differed in terms of their year of study. In addition, question by question analysis was conducted in order to find out pre-service teachers' alternative concepts about the Moon. Data analysis showed that year of study did not have an influence on pre-service teachers' achievements in concepts about the Moon. In addition, it was found that pre-service teachers had some alternative concepts and as their year of study advanced, these concepts did not change much. Some of these alternative concepts are: "the Moon will be in the full moon phase during the Solar eclipse", "Solar eclipse will occur in Sun-Earth-Moon cycle", "phases of the Moon will be new moon-first quarter-last quarter-full moon", "a full rotation of the Moon around the Earth will last for 1 day or 1 year". In line with these results, it was recommended for institutions educating Science teachers to revise their Astronomy lesson.

Keywords: Astronomy, moon, alternative concept

INTRODUCTION

Human beings have been looking at the sky for thousands of ages and only we have the privilege of being the first generation to have a respected, reasonable and rational explanation about the running of the universe (Singh, 2010). The science of astronomy, which gives deep knowledge about our cosmic roots, our place in space and time, the origin and the evolution of the sun and its planets, other stars and planets, has been a field of science that arouses people's curiosity since the first day of humanity and it is the science that people have most reflected upon (Percy, 2006). At the same time, astronomy has become a living and dynamic science that survives by studying the Earth and the universe in detail and updating existing information with new information. Besides, people have frequently made use of astronomy in daily life while making calendars, measuring time, commenting on daily and seasonal events and temperature changes and finding directions (Percy, 2006).

Astronomy concepts are generally difficult to understand, they require top use of imagination and three-dimensional thinking, they are associated with the quality of comprehension and due to these reasons, teaching astronomy concepts requires special methods. Studies have mostly focused on

understanding the concepts of the shapes of the Sun, the Earth and the Moon, phases of the Moon, universal distance, universal size and seasons and finding out alternative concepts of these concepts (Kıroğlu, 2015). Of these concepts, concepts such as moves and phases of the Moon and eclipses have generally not been examined directly, but they have been examined indirectly among the basic concepts of astronomy (Türk, 2015a). Thus, this study conducted directly on the concepts of moves and phases of the Moon and eclipses can contribute to the gap in literature.

There are some studies in literature conducted with different age groups on some of the concepts of moves and phases of the Moon and eclipses (there are no studies focusing on all of these concepts). According to Dunlop (2000), most of the students have difficulties in understanding moves and phases of the Sun and the Moon. Similarly, according to Cohen and Lucas (1999)'s study, the most frequent alternative concept among basic astronomy concepts is about the phases of the Moon. In the same study, it is also suggested by pre-service teachers that phases of the Moon occur with the shadow of the Earth falling on the Moon. In parallel with this result, Trundle and Troland (2005) stated that a great majority of primary school students and teachers think that phases of the Moon occur due to the shadow of the Earth.

Studies On Phases, Moves and Eclipses of the Moon Conducted with University Students

When studies on phases, moves and eclipses of the Moon conducted with university students and/or pre-service teachers are examined, it can be seen that these studies have focused on one concept (phases of the Moon). The reason why the present study is conducted with pre-service teachers is to find out the current state of pre-service teachers who will teach these concepts in the future and to prepare a basis for researchers who will research on this field in the future. According to Brunsell and Marcks (2005), students' understanding basic astronomy concepts is associated with teachers' having comprehended astronomy concepts very well and knowing how they can transfer these concepts in the best way possible. Studies show that teachers, especially primary education teachers, have very little knowledge about astronomy (Percy, 2006). According to Taşcan (2013), about 50% of science teachers do not know why we always see the same side of the Moon and they cannot visualize the actual situation in their minds. In addition, studies in this field show that science teachers have insufficient information about how the phases of the Moon occur. In another study, Skam (1994) found that pre-service teachers had alternative concepts such as phases of the Moon occurred by the shadow of the Earth and the rotation of the Moon around the Earth lasted a week.

Bayraktar (2009) stated that most researched subject in the past was "understanding the phases of the Moon". Black (2004) stated that in an earth sciences inventory given to students, students stated that the most difficult phase for them was the half-moon phase.

In their study, Bisard et al. (1994) stated that 40% of university students had the alternative concept that "*phases of the Moon depend on the sunlight reflecting from the Moon*". In a wide scale study by Trumper (2001), which included university and high school students and which measured their basic astronomy knowledge, it was emphasized that the students thought the reason for the phases of the Moon was "the shadow of the Earth falling on the Moon". In another study by pre-service teachers, the concept of eclipse was found to be the most frequent answer for the reasons of lunar phases (Callison & Wright, 1993; Dai & Capie, 1990; Schoon, 1995). The basis of alternative concepts of students about the moves and eclipses of the Moon is teacher's lack of knowledge. According to Stahly, Krockover and Shepardson (1999)'s study, the most frequent incorrect information about the phases of the Moon in students between the ages 9 and 16 can be listed as thus:

- Clouds cover the surface of the Moon and it becomes invisible and phases occur.
- Since the shadows of planets fall on the Moon, it becomes invisible and phases occur.
- Since the shadows of the Sun fall on the Moon, it becomes invisible and phases occur.
- Since the shadows of the Earth fall on the Moon, it becomes invisible and phases occur.
- Phases of the Moon were explained in terms of the light side seen from the Earth.

The Purpose and Research Questions of the Study

The objective of this study is to find out the level of information pre-service Science teachers about the phases, moves and eclipses of the Moon which are concepts related to the "Moon", and their alternative concepts, if they have any. Another objective of the study was to examine the effects of pre-service teacher's grade on their academic achievement and the elimination of alternative concepts. In line with this objective, answers were sought to the following problem and sub problems. The main problem statement of this study is;

"How are pre-service teachers' levels of achievement about the moves, phases and eclipses of the Moon?"

Within the context of this problem statement, answers were sought to the following sub problems.

- Is there a significant association between students' grade and their levels of achievement about the moves, phases and eclipses of the Moon?
- How do students' alternative concepts (if any) about moves, phases and eclipses of the Moon change according to their grade?

METHOD

This study is a descriptive (survey) study conducted to find out pre-service teachers' level of knowledge of knowledge and alternative concepts about "Moon" related concepts. Survey research designs are procedures in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviors, or characteristics of the population (Creswell, 2012). In this research the data collected at just one point in time using cross sectional survey which is one of the survey designs. The cross sectional survey collects information from a sample that has been drawn from a predetermined population (Fraenkel, Wallen and Hyun 2012).

Sample

The sample of the study consists of pre-service science teachers from a chosen university in the Black Sea Region. In order to reach the sample, simple random sampling method, which is one of the random sampling methods, was used. To this end, a total of 306 students – 71 from first grade, 77 from the second grade, 77 from the third grade and 21 from the fourth grade- were chosen randomly among pre-service teachers studying their 1st, 2nd, 3rd and 4th grades by using simple random sampling method.

Data Collection Instrument and Data Analysis

In the study, MAT, which had 10 questions, was used to find out the level of knowledge of pre-service teachers about the concept of Moon. The items of the test were chosen from questions related with the "Moon" within the "Astronomy Achievement Test" developed by Türk (2015b). KR-20 reliability coefficient of the test used in the study was found to be 0.52. This result is in line with other studies conducted with similar scale (Türk, 2015b). MAT is a test based on four options and some information about the test was given in Table 1.

Table 1: Information about MAT

	Total Item	N	Difficulty p	Discrimination r_{ijx}	KR-20
MAT	10	306	0,54	0,41	0,52

SPSS 22.0 statistical program was used for the data obtained from the implementation of MAT. Before the statistical analysis, descriptive analyses were calculated for the scores taken from each test. After this, the following criteria were analyzed to find out which parametric/non-parametric technique to use for data analysis.

- Are the data normally distributed or no?
- Is the study group more/less than 30 people?

While determining the analysis technique of quantitative data, the data should be tested for having normal distribution. If the data have a normal distribution, parametric tests are used in analysis. The second point to take into consideration is the number of people to compare in groups. If the number of participants in groups is more than 30, it is possible to use parametric tests assuming that the results obtained from the data will be distributed normally (Can, 2014).

The number of pre-service teachers in this study is more than 30. Thus, the criterion that having a number of participants more than 30 was fulfilled. Normality tests were conducted to test whether the data were normally distributed, which is another criterion. Normality test results of MAT are given in Table 2.

Table 2: The Results of Normality Tests

	Kolmogorov-Smirnov		
	Statistic	df	p
MAT	,137	306	,200*

*p>,05

When Table 2 is analyzed, it can be seen that the data were normally distributed in all groups. Thus, parametric analysis techniques were decided upon to be used in the analysis of MAT data.

One-way variance analysis (One-Way Anova) technique was used to find out whether there was significant difference between the AAT, AAS and PSVT-R scores of pre-service teachers in terms of their years of study. One-way variance analysis is used to find out whether the difference between the averages of two or more unrelated samples is different from zero significantly (Büyüköztürk, 2005; Can, 2014). The level of significance was taken as 0,05 while interpreting the statistical analyses results.

FINDINGS

The findings were presented in two sub titles as results of MAT total scores and results of question by question analysis.

Findings of MAT

Table 3 presents descriptive statistics that include pre-service teachers' average achievement scores and standard deviation values from MAT.

Table 3: Descriptive Statistics of MAT

Grade	N	Mean	SD
1 st	71	5,2535	1,49014
2 nd	77	5,2208	1,97766
3 rd	77	5,2727	1,68301
4 th	81	5,6790	1,64185

When Table 3 is analyzed, it can be seen that average MAT scores of 1st, 2nd and 3rd grade students were very close, while average MAT scores of 4th grade students were partly higher than those of other groups.

Table 4 gives the one-way variance analysis results of whether pre-service teachers' MAT scores differed significantly from each other in terms of their grade.

Table 4: One-Way Variance Analysis of MAT Scores

Source of variance	Sum of squares	df	Mean square	F	p
Between Groups (Year Level)	11,125	3	3,708	1,267	,286
Within Groups	883,610	302	2,926		
Total	894,735	305			

According to Table 4, no significant difference was found between pre-service teachers' MAT scores in terms of students' grades ($F_{3-305}=1,267, p>,05$). This result shows that pre-service teachers' grade did not have an effect on their success about concepts related with the Moon.

Question by Question Findings

This part of the study has the correct answer frequency-percentage values and the change rates of the alternative concepts pre-service teachers had.

Table 5 gives the changes of pre-service teachers' correct answer rates for each question in MAT in terms of grade.

Table 5: Question by Question Correct Answer Rates in Terms of Grade

Question No / Grade	1 st Grade		2 nd Grade		3 rd Grade		4 th Grade	
	f	%	f	%	f	%	f	%
Question 1	20	28,2	35	45,5	37	48,1	34	42,0
Question 2	33	46,5	35	45,5	32	44,2	27	33,3
Question 3	49	69,0	61	79,2	52	67,5	57	70,4
Question 4	44	62,0	46	59,7	55	71,4	66	81,5
Question 5	55	77,5	33	42,9	49	63,6	52	64,2
Question 6	44	62,0	43	55,8	42	54,5	48	59,3
Question 7	26	36,6	28	36,4	15	19,5	33	40,7
Question 8	47	66,2	32	41,6	40	51,9	52	64,2
Question 9	10	14,1	22	28,6	30	39,0	23	28,4
Question 10	51	71,8	52	67,5	49	63,6	68	84,0
Mean	-	53,4	-	50,3	-	52,3	-	56,8

When the averages of question-question correct answers were analyzed in table 5, it was found that 2nd grade pre-service teachers had the lowest correct answer percentage while 4th grade pre-service teachers had the highest correct answer percentage.

Besides the analysis of the correct answers of pre-service teachers to the questions, the study also tried to find out the most common alternative concepts they had. Table 6, which was prepared in line with these results, showed pre-service teachers' alternative concepts and the changes in these alternative concepts according to grade.

Table 6: The Percentages of the Most Widespread Alternative Concepts of Pre-Service Teachers

<i>Concept</i>	Alternative Concept	1st Grade (%)	2nd Grade (%)	3rd Grade (%)	4th Grade (%)
<i>Moon's rotation (around Earth)</i>	1 day	38,0	27,3	28,6	34,6
	1 year	19,7	22,1	18,2	16,0
<i>Processing of the moon phases</i>	New moon- first quarter- last quarter- full moon	33,8	31,2	31,2	35,8
<i>Always the same face of the moon</i>	The moon's speed around the Earth does not change	25,4	10,4	14,3	16,0
<i>Crescent phase</i>	First quarter phase	18,3	15,6	24,7	9,9
<i>New moon</i>	Full moon	9,9	20,8	23,4	13,6
<i>Solar eclipse</i>	Full moon	77,5	61,0	49,4	60,5
<i>Lunar eclipse</i>	Solar eclipse	25,4	19,5	24,7	11,1

DISCUSSION AND CONCLUSION

This study, which was conducted to find out basic astronomy knowledge, analyzed the level of knowledge pre-service science teachers had about the stages, moves and eclipses of the Moon and their alternative concepts (if any). Within this process, AAT was applied on the groups and the scores were compared with their total scores. This study met its objective to a certain level because the research method has specific limitations. At the end of the study, it can be stated that pre-service science teachers were not able to comprehend the subjects of phases and moves of the Moon, and Lunar Eclipse in all grades. At the same time, it was also stated that pre-service teachers developed many alternative concepts. These results are in parallel with Percy (1998)'s results that there exist alternative concepts which are problems of astronomy education in international arena and which are not possible to go away with classical teaching techniques and teachers could not comprehend astronomy concepts completely. No significant difference was found between the levels of achievement of science teaching department 1st-4th grade students about the subject of the "Moon".

When the astronomy lesson content of Science teaching department of education faculties is analyzed, it can be said that this lesson exists only in the spring semester of 4th grade as 2 credits. The content of this 2 credit lesson are Kepler Laws and the structure of the Solar system: planets and their features, satellites. General design of the Universe: galaxies, formation of the stars, red giants, neutron stars, white dwarfs and black holes (CHE, 2016). One of the reasons why pre-service teachers cannot eliminate their alternative concepts about moves, phases and eclipses of the Moon is the fact that a limited time and credit is allocated to the field of astronomy in Science teaching undergraduate program. Since this study was conducted before the astronomy lesson was taken, difference between classes may not have occurred. If the study had been conducted in June, there could be a more different result. However, it can still be said that the level of achievement was insufficient for pre-service teachers in science teaching department.

Interesting results were found about the alternative concepts of pre-service teachers after question by question analysis. In general, while the most successful grade was 4 (56,8%), the least successful grade was 2 (50,3%) followed by first grade. The results show that there is no association between AAT achievement and grade.

While the scientific answer for the question "For a person in the Earth to be able to observe the Total eclipse of the Sun, what phase does the Moon should have?" was "the New Moon" for all levels, the answer was "the Full Moon" mostly for all levels. In addition, it was found that pre-service teachers



formed the highest number of alternative concepts in the question of what phase of the Moon it was while there was a solar eclipse on the Earth. When the answers to the research question "What is the basic reason that we always see the same side of the Moon?" were analyzed, no association was found between grades and the level of achievement. It is possible to say that the same result was valid for all research questions by looking at the achievement scores in terms of grades. This situation shows the insufficient knowledge of undergraduate students in the field of astronomy. When these results were analyzed, the efficiency and sufficiency of astronomy education given in the department of science teaching should be discussed.

It was found that the subject pre-service teachers had the most alternative concepts was the phases of the Moon. Another alternative concept was the rate of answers about the rotation of the Moon. When it is considered that astronomy education is given only in 8th semester of the whole education process with the content and number of credits, it is thought that these flaws can have occurred. In addition, while Astronomy science should be supported with applicable lessons, it was found as a result of this study that there are no applicable lessons.

When all the results were considered, it can be understood that there are some troubles about the astronomy education in the department of Science teaching and that even if pre-service teachers took this lesson, they could not use their knowledge effectively. While the science of astronomy becomes more and more important each day in the world of science, new studies should be conducted in our country to keep up with this world.

SUGGESTIONS

As can be seen in literature, since astronomy course requires thinking 3 dimensionally and creativity, astronomy education can be supported with 3D computer simulations or concrete physical models.

Since the research gives an account of the present situation and readiness of students, future teaching plans can be conducted in the light of this and similar researches.

As can be understood from the results of the study, concepts about the Moon and its moves are the concepts pre-service teachers can develop too many alternative concepts. Thus, experimental studies can be conducted which test the efficiency of various method and techniques for the elimination of these alternative concepts.

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