Eğitim ve Bilim
2013, Cilt 38, Sayı 168

Education and Science
2013, Vol. 38, No 168

The Development of Astronomy Concept Test for Determining Preservice Science Teachers' Misconceptions About Astronomy

Fen Bilgisi Öğretmen Adaylarının Astronomi Hakkındaki Kavram Yanılgılarının Tespiti İçin Astronomi Kavram Testinin Geliştirilmesi

Behzat BEKTAŞLI*

Hacettepe University

Abstract

Astronomy is fairly a new course for preservice science teachers in Turkey. Regardless of many science courses taken, preservice science teachers hold several misconceptions about astronomy. It is essential to find out those misconceptions to facilitate astronomy teaching. The aim of this study is to develop a new astronomy instrument specifically related to the topics of grade 4 through grade 8. The main reason for that is to find out preservice science teachers' astronomy misconceptions specifically related to these topics. Preservice science teachers wrote journals after each astronomy class during a semester and the test has been developed mainly based on these journals. After a pilot study, the instrument had reduced to 18 items. The cronbach alpha value determined as 0.71 for the main study. Data analyses showed that preservice science teachers hold several misconceptions about astronomy. The instrument is a multiple choice test, but in addition participants asked to state if they were sure or not sure of their answers at the end of each question. Results showed that the majority of preservice science teachers that gave correct answers were not sure of their answers.

Keywords: astronomy education, concept test, misconceptions, preservice science teachers

Öz

Türkiye'de astronomi dersi, fen bilgisi öğretmen adayları için oldukça yeni bir derstir. Fen bilgisi öğretmen adayları birçok fen dersi almış olmasına rağmen astronomi hakkında oldukça fazla kavram yanılgısına sahiptir. Bu kavram yanılgılarının ortaya çıkarılması, astronomi eğitimini kolaylaştırmak açısından gereklidir. Bu çalışmanın amacı, özellikle 4. sınıftan 8. sınıfa kadar olan astronomi içeriği ile ilgili bir astronomi testi geliştirmektir. Bunun temel nedeni, fen bilgisi öğretmen adaylarının özellikle bu içerik ile ilgili kavram yanılgılarını tespit etmektir. Fen bilgisi öğretmen adayları bir dönem boyunca astronomi dersinde günlük tutmuş ve test temel olarak bu günlükler üzerinden oluşturulmuştur. Pilot çalışmadan sonra testteki madde sayısı 18'e düşürülmüştür. Cronbach Alfa değeri ana çalışma için 0.71 olarak hesaplanmıştır. Veri analizi, fen bilgisi öğretmen adaylarının astronomi ile ilgili birçok kavram yanılgısına sahip olduklarını göstermiştir. Ölçekteki sorular çoktan seçmeli olup buna ek olarak her soru sonunda katılımcıların cevaplarından emin olup olmadığı sorulmuştur. Sonuçlar, fen bilgisi öğretmen adaylarının doğru cevap verdikleri soruların büyük çoğunluğunda verdikleri cevaplardan emin olmadıklarını ortaya koymuştur.

Anahtar Sözcükler: Astronomi eğitimi, kavram testi, kavram yanılgıları, fen bilgisi öğretmen adayları.

Introduction

Astronomy is one of the oldest sciences in human history. Human beings always tried to understand the motion of stars and planets. Even today we try to understand the universe in

* Dr. Behzat BEKTAŞLI, Hacettepe University, Faculty of Education, Department of Science Education, Ankara, Turkey. E-mail: bektasli@hacettepe.edu.tr

more depth. Astronomy somehow takes place in our life, through media, school or amateur observations. However, the history of astronomy education is not that old specifically for preservice science teachers in Turkey. In other words, most of the Turkish preservice science teachers are naïve learners of astronomy.

Students have several misconceptions in astronomy (Bailey & Slater, 2003; Zeilik & Morris, 2003). Most of these misconceptions come from real life experiences (Ozdemir & Clark, 2007; Sewell, 2002, Strike & Posner, 1982). Like students, many preservice science teachers are also amateur astronomers who observe the sky day and night. For example, they have some ideas about the motion of sun based on their observation of sunrise and sunset. It is very crucial to deal with those misconceptions during their teacher training program. Otherwise misconceptions may remain constant and transferred to their students.

Turkish preservice science teachers take astronomy course for the first time at very last semester of their teacher training program. Therefore their astronomy knowledge so far is mainly based on what they have learned in previous science courses and their amateur observations. However, students usually encounter problems relating course content into another. Thus, if students cannot truly relate physics content into astronomy they will probably have some difficulties in astronomy class. For example, students need to apply Kepler's laws of planetary motion into astronomy to understand the motion of planets around the sun. At this point students may bring some astronomy misconceptions from physics class if they misinterpreted Kepler's laws of planetary motion.

Zeilik, Schau, and Mattern (1998) stated that some astronomy misconceptions are deeply rooted like the ones related to light, so even an intense course may not help students to overcome those misconceptions. That is why Zeilik et al (1998) recommends instructors to first identify the misconceptions to be studied and then cover fewer topics with a deeper instruction. In another words, less is more.

Common Conceptual Difficulties Regarding Astronomy

Many studies concluded that students hold series misconceptions about astronomy (Bisard, Aron, Francek, & Nelson, 1994; Trumper, 2006; Zeilik et al., 1998). The most common misconceptions are related to day-night cycle (Lightman & Sadler, 1993; Trumper, 2000), moon phases (Bisard et al, 1994; Trumper, 2000; Zeilik et al, 1998), dimensions (Trumper, 2000; Zeilik, 1998), seasons (Trumper, 2000), position of sun during daytime (Trumper, 2000; Zeilik et al, 1998), distances of objects from Earth (Trumper, 2000), moon's revolution (Trumper, 2000), moon's rotation (Trumper, 2000; Zeilik et al, 1998), moon phases (Zeilik et al, 1998), solar eclipse (Trumper, 2000; Zeilik et al, 1998), and center of universe (Trumper, 2000).

Astronomy Diagnostic Test (ADT) is the most well known astronomy instrument. It has ADT 1.X (Zeilik, Schau, Mattern, Hall, Teague, & Bisard, 1997; Zeilik, Schau, & Mattern, 1999) and ADT 2.0 (Zeilik, 2003) versions. The test has a bank of 29 questions. Zeilik et al (1998) used 15 questions from ADT 1.X to investigate science and non-science majors' astronomical concepts. Zeilik (2003) noted that ADT 2 has only two items in common with ADT 1.X. According to Zeilik (2003) ADT 2.0 is much more difficult instrument compared to ADT 1.X, because of its design.

Lightman and Sadler (1993) and Trumper (2000) developed astronomy tests to find out students' misconceptions. Lightman and Sadler (1993) prepared a test of astronomy and related subjects that has 16 questions. The instrument of Bisard et al (1994) is mainly related to physical science and earth science misconceptions. Trumper (2000) used the instruments by Bisard et al (1994), Lightman and Sadler (1993), and Zeilik et al (1998) to construct *Misconception Measure* test. Similarly, Kalkan and Kiroglu (2007) used these three instruments and developed a questionnaire with 14 questions. In addition, Ünsal, Güneş and Ergin (2001) developed a 31 open ended question test. Similarly, Emrahoğlu and Öztürk (2009) developed Astronomical Concept Test (ACT) which consists of 13 open ended questions.

The Research Aim and Significance of the Study

Elementary education in Turkey is 8 year long and mandatory. Students have science and technology course from grade 4 through grade 8. Astronomy topics are part of the science and technology course in elementary school. The new curriculum for science and technology course was established in 2004 (MEB, 2004) so it is fairly new.

Astronomy is even a newer course for pre-service elementary science teachers in Turkey. Elementary science teacher training program has been changed parallel to the change in curriculum of elementary education. The application of the new program for preservice science teachers started in 2006 (YOK, 2006). Since the astronomy course is at the fourth year of the program, preservice science teachers first met with astronomy in spring 2010. Therefore there was a six year gap between the new science and technology course curriculum in elementary school and astronomy course in science teacher training program. As can be seen, astronomy education is pretty new for preservice science teachers. None of the participants in this study had an astronomy course either in high school or college level. They had approximately 60 credit hours science courses during seven semesters of their teacher training program.

The main reason for developing a new instrument is to find out preservice science teachers' misconceptions about astronomy. The instruments developed so far are poor in terms of covering the content of elementary science and technology education curriculum. Therefore the test developed related to the astronomy topics that included in the new elementary science and technology curriculum. The list of these topics is given in Table 1. Astronomy topics in the new curriculum are from grade 4 through grade 8. It is very essential to find out preservice science teachers' misconceptions specifically related to these topics, because some misconceptions transferred to students from their teachers. Therefore, it is very important to be aware of preservice science teachers' misconceptions before astronomy instruction. Determining preservice science teachers' astronomy misconceptions may facilitate astronomy learning especially by focusing in depth with those misconceptions. That was the main objective for developing the Astronomy Concept Test (AstroCoT). AstroCoT is a multiple choice instrument that tests preservice science teachers' basic astronomy concepts.

Table 1.
Astronomy Topics in Elementary Science and Technology Education Curriculum.

Grade	Topic
4	Planet Earth
5	Earth, Sun and Moon
6	The Features of Earth's Crust
7	Solar System and Beyond
8	Seasons

Methodology

Participants

The first stage of the study had 73 preservice science teachers attending astronomy course in spring 2011 at their last year of teacher training program. In the second stage, 230 preservice science and mathematics teachers from different levels (first, second, and third year of teacher training program) participated in the pilot study. Finally, the participants of the main study were 82 preservice science teachers at their last year of teacher training program in spring 2012.

Development of Items

Pre-service science teachers who attended spring 2011 astronomy class have been assigned to keep journals about what they have learned during the course. The content of the course was based on the topics that have been included in the elementary science and technology education curriculum. Pre-service science teachers have especially told to focus on misconceptions that they used to have before the class. For example, if a preservice science teacher used to know that the moon is a source of light and then in the class s/he found out that the moon actually is not a source of light, then the preservice science teacher has been expected to state that in the journal. At the end of the semester the journals of 73 participants' have been analyzed. Based on that analysis, the most common misconceptions that preservice science teachers hold have been listed and the first edition of the test with 26 multiple choice questions was formed. Then questions were discussed with an astronomy expert and some corrections were made. After that a second interview has been conducted with another astronomy expert for the purpose of content validity of the test. The number of items reduced to 24 items after that interview. Next, the instrument has been evaluated by Turkish language expert for clarity of the statements. In addition, a test development expert has checked the items for validity.

Pilot Study and Item Reduction

The pilot study conducted with 230 preservice science and mathematics teachers in department of elementary education. After the pilot study some items have been deleted and the last form of the test consisted of 18 items. The last form of the test applied to 82 fourth year pre-service science teachers before their astronomy class. The data analyzed and the results discussed with an astronomy expert.

Students usually do not have adequate knowledge in a new course (Zeilik et al., 1997). Therefore, the researcher usually does not have an idea if a student really knows the answer or if s/he just guessed. Students may answer some items correctly by guessing and that may increase their success on a multiple choice test (Doğan & Gelbal 2007; Turgut, 1971). It is common to ask the participants to state if they are sure or not sure of their answers. However, this question is usually asked at the end of the instrument. That does not seem so effective, because the participants can be sure of their answers for some questions and not sure for others. Therefore, the participants in this study have been asked to decide if they were sure or not sure of their answers at the end of each question. That was a good way to find out if participants really knew the answer of a specific question or if they just guessed. Based on the analysis it was found that most of the preservice science teachers were not sure about their answers.

Data Analysis

Zeilik et al. (1997) noted that since students are novices when they take a new course, the internal consistency of achievement measure is generally low. Naïve learners will probably guess when they take such kind of achievement test. Baykul (2000) noted that the chance factor in a test affects the reliability and validity of the test. In their study, Zeilik et al calculated the Cronbach's alpha value 0.43 on the pretest and 0.67 on the post-test. Cronbach's alpha value is acceptable when it is 0.65 and higher (Zeilik et al, 1997).

Reliability analysis of the pilot study showed that the Cronbach's alpha value was 0.42 for AstroCoT with 24 items. After that, the data re-coded to find out if participants who just guessed were changing the reliability or not. Participants that gave correct answers were originally coded as 1. However those participants' scores were re-coded as 0 if they were not sure of their answer. In other words, if a participant gave a correct answer but not sure of her/his answer that means the participant knew the correct answer by chance. After recoding, the data analyzed and the Cronbach's alpha value was increased to 0.61. Based on the pilot study some corrections were made by using iteman analysis and six items have been eliminated. The instrument for the main study had 18 items. In the main study, the Cronbach's alpha value initially was 0.49. After

recoding the data for the same reason in the pilot study the Cronbach's alpha value increased to 0.71.

Scale statistics of AstroCoT is presented in Table 2. As can be seen from the table the skew value was 0.51. Since the frequency is positively skewed it can be concluded that only few participants got high scores. Similarly, kurtosis value was -0.68. Kurtosis is a description of the shape of probability distribution, so the distribution was not exactly a normal distribution.

Table 2.
Scale Statistics of Astronomy Concept Test

N of items	N	Cronbach's alpha	Mean	Variance	Std. dev.	Skew	Kurtosis	SEM	Mean P
18	82	0.71	3.51	6.71	2.59	0.51	-0.68	1.41	0.19

Table 3 presents the percentages for each response along with the percentages of participants whose correct answer is based on guessing. For example, in item 3, 50% of the participants gave correct answer, however 51% of those was not sure of their correct answer. It is very clear from Table 3 that the majority of preservice science teachers were not sure of their correct answers, which means that most of them guessed. In item 6, none of the students was sure of their correct answers. This shows that even preservice science teacher who gave correct answers do not have good astronomy knowledge.

Table 3.
Percentages of Preservice Science Teachers Selecting a Specific Choice. The Correct Answer is Boldface Italic.

Item	A	B	C	D	E	Guess***	Point biserial coefficent 1*	Point biserail coefficent 2**
1	6.1	***40.2***	7.3	30.5	15.9	49	0.50	0.39
2	17.1	***34.1***	11	36.6	1.2	75	0.42	0.41
3	9.8	12.2	***50***	12.2	15.9	51	0.41	0.50
4	***42.7***	8.5	20.7	7.3	20.7	46	0.51	0.57
5	4.9	3.7	12.2	***75.6***	3.7	23	0.51	0.58
6	17.1	24.4	13.4	***9.8***	35.4	100	0.19	0.00
7	2.4	***85.4***	7.3	4.9	0	21	0.50	0.41
8	***34.1***	46.3	1.2	1.2	17.1	54	0.37	0.39
9	9.8	4.9	***22***	29.3	34.1	44	0.17	0.21
10	14.6	***9.8***	11	14.6	50	50	0.38	0.35
11	24.4	9.8	34.1	8.5	***23.2***	68	0.16	0.25
12	3.7	36.6	1.2	41.5	***15.9***	76	0.18	0.41
13	30.5	1.2	11	1.2	***54.9***	40	0.63	0.66
14	13.4	18.3	39	***12.2***	17.1	90	0.22	0.19
15	***12.2***	24.4	13.4	46.3	3.7	20	0.20	0.24
16	24.4	19.5	17.1	***30.5***	8.5	64	0.52	0.49
17	***64.6***	2.4	3.7	20.7	8.5	51	0.49	0.53
18	26.8	6.1	23.2	14.6	***29.3***	38	0.35	0.39

*Notes: *Point biserial coefficient for the main data*
***Point biserial coefficient for the main data after correct (1) but not sure responses converted to false (0)*
****The percentage of participants who responded correctly but not sure of their responses*

The point biserial coefficients before and after data recoding are presented in Table 3. As can be seen from the table the point biserial coefficients for most of the items increased after the data recoded. Point biserail coefficient is usually desired to be at least 0.30. If this value is between 0.20 and 0.30 that means this item still can be used by minor revisions. The mean P values were for 0.33 before recoding and 0.19 after recoding. The test gets more difficult when the

mean P value approaches to zero and easier when it approaches to 1. Mean P values show that AstroCoT is difficult for students. The main reason for that seems to be that astronomy is quite a new course for preservice science teachers. That also might be one of the reasons to have some items' point biserial coefficients below 0.30. For example, in item 9 students need to know the difference between rotation and revolution. After administration of the test, many students asked the researcher the difference between rotation and spin. In item 6, the point biserial coefficient did not increase after recoding. As can be seen from Table 3, only 9.8% was able to answer this question correctly; however 100% of those students were not sure of their correct answer. Similarly, in question 14 only around 12% of participants gave correct answer. However, 90% of those students were not sure of their correct responses. This is most probably why the point biserial coefficient was low (0.19) for that item.

Results

Analysis of Individual Items

In the following analysis the percentage of preservice science teachers who gave correct answer is presented first. Then the total percentage of a certain misconception is presented. For example, in question 12, three statements are given and participants are asked to find out the correct statements. The third statement (III) is "Planets are smaller than stars". Then to find out the total number of students who believed that this statement was incorrect the researcher added all the choices that do not include the statement III. In question 12, statement III does not exist in choice A, B, and D, so by adding the percentages of these choices it is found that approximately 82% of students believed that planets are bigger than stars.

Question 1

Approximately 40% of the participants believed that stars are not solid. The astronomy expert said that 40% is good for that item. Students usually do not know the difference between a planet and a star. That may lead many students to believe that stars are solid. In addition, 29% of the participants thought that the number of stars does not change by time. Finally, about 54% of the participants agreed that stars does not born, live, and die.

Question 2

The correct answer for this item is Sun, and 34% of the participants gave correct answer to this question. This result is very remarkable because 66% of the participants did not know that the star they see on the sky everyday is actually the closest one to the Earth. Some of these participants may not even know that the Sun is actually a star. In fact during astronomy class some students stated that they did not used to know the Sun as a star. In fact, many students in the class did not know the differences between a planet and a star. Approximately, 37% of students marked Polaris as the closest star to Earth. According to astronomy expert Polaris is a well known popular star and that might be one of the reasons for students to mark that choice. In Turkish Polaris is named as "*Kutup Yıldızı*" which means *Pole Star*. On the other hand, the Sun is named as "*Güneş*". In conclusion, the Sun does not have a star word next to it as Polaris, and that might be one of the reasons to think Polaris as a star but not the Sun.

Question 3

In this item, 50% of students gave correct answer to that question. About 24% of students believed that all planets have satellite. Surprisingly, 40% of students agreed that planets are source of light. This supports the idea in Question 2 that many students do not know the difference between a planet and a star.

Question 4

In that question, 43% of students gave correct answer by stating that the moon is not a source of light. However, about 16% of students thought that the moon is a source of light. The astronomy expert said that the main reason for that might be seeing the moon shiny at night.

Question 5

This is one of the questions that most students answered correctly (76%). These students believed that the position of Moon according to Earth will not affect the formation of seasons. About, 12% of students believed that the structure of atmosphere does not affect the formation of seasons. According to astronomy expert those students probably did not think of green house effect.

Question 6

In this question only 10% of the participants gave correct answer. The statement II is probably the tricky one in that question. Statement II states that "Generally further stars seem dimmer". It seems that students did not think the $E=I/d^2$ equation in physics (E:Illuminance, I:Light Intensity, d:Distance). In addition, about 38% of students thought that planets revolve around the Sun at constant speeds. It can be concluded that those students have serious misconception about Kepler's Laws. Finally, 41% of students believed that Solar System is located at the center of Milkyway.

Question 7

This item has 85% correct answers. It is noticeable that most of the students know that the moon is the main reason for tides. The astronomy expert said that students facing the concept of tides and moon since the 4^{th} grade in many science courses, therefore the result was not a surprise.

Question 8

Approximately 34% of students gave correct answer to that question by stating that Yuri Gagarin is the first man who went to space. It seems that some students confuse the term space and moon, or they may get the same meaning from space and Moon. Students do not seem to perceive the space as being out of the atmosphere. About 46% of students marked Armstrong as the first man who went to space. Those students also seem to confuse the term space and Moon. The astronomy expert said that students who marked Apollo (17%) probably heard that name from media more compared to other names.

Question 9

Only 22% of the participants gave correct answer to this question. It is very obvious in this item that students do not know the difference between rotation and revolution. In fact, right after administration of the test many students in the classroom asked the researcher the difference between these two terms. The astronomy expert agreed that many students usually do not know the distinction between these two terms.

Question 10

No more than 10% of the students answered this question correctly. Students who believed a blackhole is an infinite vacuum were 79%. About 61% of students thought that meteor shower is actually displacement of a star. As in question 2, Turkish might be an issue in this question. The term meteor shower is called "*yıldız kayması*" in Turkish, which can be translated as "*displacement of a star"*. Since the meteor shower includes the word *star (yıldız)* in Turkish, it might have influenced students' understanding of meteor shower. Similar use exists for Venus. The terms "*Çoban Yıldızı*" and "*Venüs*" are used interchangeably in Turkish for Venus. That is most probably why many people know "Ç*oban Yıldızı*" as a star, but not actually the planet Venus.

Question 11

In this item 23% of students responded correctly. However, around 59% of students believed that the moon is spherical. According to astronomy expert the main reason for that is based on the observation of moon. When students look at the moon they perceive it as a sphere. Moreover, about 34% of students thought that the Earth is a sphere. In Turkish national science education curriculum instead of geoids the term spherical is used for Earth's shape, and that might have caused the participants to hold this misconception.

Question 12

Only 16% of students answered this question correctly. The astronomy expert thought that in general students see Saturn with rings. This is probably why 45% of students thought that only Saturn has rings. One of the most important misconceptions in this item is that 82% of students believed that planets are bigger than stars. Again that might be related to observation. Students see stars very small on the sky however in many pictures they see the planets very big compared to stars.

Question 13

About 55% of the students gave correct answer to this question. Those students knew that Jupiter is the largest planet in our solar system (statement I) and the universe is expanding (statement III). The astronomy expert expected a higher percentage for correct answer. The expert was really surprised that 33% of students did not know the universe is expanding and 13% of students did not know that Jupiter is the largest planet in our solar system. According to astronomy expert, students who did not know the universe expands marked choice A which only states that Jupiter is the largest planet in our solar system (statement I).

Question 14

Only 12% of students marked the correct choice for this item. The most important misconception in this question is that around 47% of students believed the stars that form constellations have common features. It seems that many students do not know that constellations are formed based on how we see them from earth. When it is asked in the classroom students did not know that constellations will be seen in different shapes from another planet or star. As a result, students probably thought that same group of stars will have the same features. Moreover, 32% of students thought that in our solar system only Earth has an atmosphere. Atmosphere is essential for our life. Since there is no life in other planets students may concluded that it is due to lack of atmosphere.

Question 15

Only 12% of students gave correct answer to this item. The astronomy expert agreed that 12% is very small. This is one of the questions that show how students demand on their observations. Students were asked to determine the months that the Earth is closest and farthest to the Sun. It is very clear that students' decisions were based on the average temperature in summer and winter. Since summer is hot they probably thought that in June or July the sun should be closest to the Earth and similarly since winter is cold the sun should be farthest to the Earth. About 71% of students demanded on their observations instead of considering at which angle the sunlight is coming to Earth.

Question 16

Students were asked to find out about how long it takes the sunbeams to reach the Earth. Approximately 30% of students marked the correct choice for this item. All of the students were supposed to know the speed of light and the approximate distance between Earth and Sun from their physics class. However, 24% of students believed that the sunlight will reach to Earth in just

one second. In addition, around 20% of the participants thought it will take 10 second, and about 17% believed it will take two minutes.

Question 17

In this item 65% of students gave correct answer. Approximately 32% of students believed that the dimension of the sun is constant and does not change by time. Those students probably did not know that the stars born, live, and die, so they did not realize that the dimension of Sun changes by time. Around 12% of students thought that planets revolve around the sun at constant distances.

Question 18

In the last question, 29% of students marked the correct choice. Approximately another 29% of students believed that planets revolve at a circular orbit around the sun. Based on that result, it can be concluded that some students have misconceptions about Kepler's laws of planetarium motion. In addition, about 50% of students thought that the planets move around the Sun, however the Sun does not move.

Conclusions and Implications

This study aimed to develop an astronomy instrument related to grade 4 through grade 8 science and technology curriculum topics to discover preservice science teachers' astronomy misconceptions. Therefore, it was very important to develop this instrument based on preservice science teachers' astronomy content knowledge. This is why preservice science teachers' kept journals during their astronomy class for one semester. The AstroCoT was mainly developed based on these journals. The results showed that preservice science teachers have very poor astronomy knowledge. After taking the test many participants stated that "we realized that we almost know nothing about astronomy".

The results of this study were consistent with Zeilik et al., (1997) in terms of being naïve to a new course. Astronomy was fairly a new course for preservice science teachers in this study. The majority of the participants that gave correct answers tended to guess, since they were not sure of their answers. This is why the reliability increased from 0.49 to 0.71 after recoding the data. The result of this study was in accord with Doğan and Gelbal (2007) and Turgut (1971) who stated that the chance factor effect students' success.

This study strongly recommends that astronomy education needs to be emphasized more in teacher training program. Participants of the study were at the last semester of their teacher training program, so they were about to graduate and start to teach in schools. Teachers will more likely transfer their misconceptions to students (Akgün, 2009). Although the participants had several science courses during seven semesters, they still have poor knowledge of astronomy. It seems that during these science courses they did not make any connection to astronomy, especially in physics and earth science. It might be more effective if students make connections to astronomy in science courses. For example, in physics classroom Kepler's laws of planetarium motion need to be connected to our solar system. It might be beneficial for students to see the relationships between different courses. Therefore, it seems to be a good idea to have another astronomy course in the second or third year of teacher training program.

The number and percentages of astronomy misconceptions determined in the current study was very high. This result was quite consistent with previous studies by Bisard et al., 1994; Trumper, 2006 and Zeilik et al., 1998. The most common misconceptions found in that study was mostly related to stars, distances, solar system, difference between rotation and revolution, meteor shower, blackholes, earth's and moon's shape, size comparison of planets and stars, constellations, seasons, the time sunlight reach to earth and evolution of stars.

Approximately 10% of science and technology curriculum dedicated to astronomy topics in elementary school. On the other hand, the new teacher training program (YOK, 2006) has only two hours astronomy course in a week for just one semester. Preservice science teachers take approximately 60 credit science courses during their undergraduate education. However, only around 2 credit hours (3%) of science courses dedicated to astronomy in preservice science teacher training program. It is obvious that the new science teacher training program was not sufficient in terms of astronomy education. The results of this research and Ucar and Demircioglu (2011) recommend increasing the number of astronomy courses for preservice science teachers.

In Turkey, astronomy education for preservice science teachers has just started in 2010. Most of the preservice science teachers come to astronomy classroom with many misconceptions. It is very important to find out what preservice science teachers know about astronomy before instruction. Zeilik et al (1998) recommended first identifying students' misconceptions and then dealing with those misconceptions by covering less topics and focusing in details on those misconceptions. Therefore identifying preservice science teachers' misconceptions is the first step. In addition, in depth instruction is required for specific astronomy misconceptions. This is why Turkish preservice science education curriculum needs to have more astronomy credit hours. Moreover, preservice science teachers need to face astronomy misconceptions in previous years of their teacher training program. Therefore, astronomy education in teacher training program needs to begin in earlier semesters instead of last semester. In conclusion, astronomy is one of the core science courses and it needs to have more consideration by curriculum developers.

Acknowledgements

I would like to thank Assoc.Prof.Dr.Nuri Doğan, Assoc.Prof.Dr.Birol Gürol and education coach Aslı Nacar for their support during the study. I would like to extend my thanks to the anonymous reviewers for their constructive criticism and suggestions.

References

Akgün, A. (2009). The relation between science student teachers' misconceptions about solution, dissolution, diffusion, and their attitudes toward science with their achievement. *Education and Science, 34*(154).

Bailey, J. M., & Slater, T. F. (2003). A review of astronomy education research. *Astronomy Education Review, 2*(2).

Baykul, Y. (2000). *Eğitimde ve Psikolojide Ölçme: Klasik Test Teorisi ve Uygulaması*. Ankara: ÖSYM Yayınları, 2000.

Bisard, W., Aron, R., Francek, M., & Nelson, B. (1994). Assessing selected physical science and earth science misconceptions of middle school through university preservice teachers. *Journal of College Science Teaching, 24*, 38-42.

Doğan, N., & Gelbal, S. (2007). Öğretmenlerin Çoktan Seçmeli Testleri Biçimlendirici Değerlendirmede Kullanımına İlişkin Bir Çalışma Örneği. Paper presented at the Uluslararası Öğretmen Yetiştirme Politikaları ve Sorunları Sempozyumu, Bakü.

Emrahoğlu, N., & Öztürk, A. (2009). Fen Bilgisi Öğretmen Adaylarının Astronomi Kavramlarını Anlama Seviyelerinin ve Kavram Yanılgılarının İncelenmesi Üzerine Boylamsal Bir Araştırma. *Çukuroava Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 18*(1), 165-180.

Kalkan, H., & Kiroglu, K. (2007). Science and nonscience students' ideas about basic astronomy concepts in preservice training for elementary school teachers. *Astronomy Education Review, 6*(1).

Lightman, A., & Sadler, P. (1993). Teacher predictions versus actual student gains. *Physics Teacher, 31*, 162-167.

MEB (Turkish Ministry of National Education) (2004). Science and technology curriculum for elementary science. Retrieved 04 April, 2012, from http://ttkb.meb.gov.tr/program.aspx

Ozdemir, G., & Clark, B.C. (2007). An overview of conceptual change theories. *Eurasia Journal of Mathematics, Science and Technology Education, 3*(4), 351-361.

Sewell, A. (2002). Constructivism and students' misconceptions. *Australian Science Teachers' Journal, 48*(4), 24-28.

Strike, K.A., & Posner, G.J. (1982). Conceptual change and science teaching. *European Journal of Science Educatipon, 4*, 231-240.

Trumper, R. (2000). University students' conceptions of basic astronomy concepts. *Physics Education, 35*(1).

Trumper. R. (2006). Teaching future teachers basic astronomy concepts-seasonal changes-at a time of reform in science education. *Journal of Research in Science Teaching, 43*(9), 879-906.

Turgut, F. (1971). *Şans Başarısının Test Puanlarına Etkisi*, ODTÜ Yayınları, Ankara.

Ucar, S., & Demircioglu, T. (2011). Changes in preservice science teacher attitudes toward astronomy within a semester-long astronomy instruction and four-year-long teacher training programme. *Journal of Science Education and Technology, 20*, 65-73.

Ünsal, Y., Güneş, B., & Ergin, İ. (2001). Yükseköğretim Öğrencilerinin Temel Astronomi Konularındaki Bilgi Düzeylerinin Tespitine Yönelik Bir Araştırma. *Gazi Üniversitesi Gazi Eğitim Fakultesi Dergisi, 21*(3), 47-60.

YOK (The Council of Turkish Higher Education) (2006). Undergraduate program for science teachers. Retrieved 04 April, 2012. from http://www.yok.gov.tr/component/option,com_docman/task ,cat_view/gid,134/Itemid,88/

Zeilik, M. (2003). Birth of the astronomy diagnostic test: Prototest evolution, *Astronomy Education Review*, *1*(2).

Zeilik, M., & Morris, V.J. (2003). An examination of misconceptions in an astronomy course for science, mathematics and engineering majors. *Astronomy Education Review, 2*(1).

Zeilik, M., Schau, C., & Mattern, N. (1998). Misconceptions and their change in university-level astronomy courses. *The Physics Teacher, 36*.

Zeilik, M., Schau, C., & Mattern, N. (1999). Conceptual astronomy II replicating conceptual gains, probing attitude changes across three semesters. *American Journal of Physics, 67*.

Zeilik, M., Schau, C., Mattern, N., Hall, S., Teague, K. W., & Bisard, W. (1997). Conceptaul astronomy: A novel model for teaching postsecondary science courses. *American Journal of Physics, 65*(10), 987-996.