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ELEMENTARY SCHOOL STUDENTS' CONCEPTIONS REGARDING ASTRONOMICAL PHENOMENA

ABSTRACT

This study has aimed to determine conceptions of 6th grade students on some basic astronomical phenomena. 374 primary school students were chosen as sampling. An "Astronomical Conception Test" prepared with the benefit of related literature and consists of nine open-ended questions was used to reveal the ideas of the students on the topic. The methodology used in analysing the data was a categorisation of the responses that are construed as having similar intended meanings. After analysing the data it has been revealed that 6th grade students have different kinds of conceptions on basic astronomical concepts. For the most frequent conceptions revealed by this research it has been suggested that conceptual change activities should be introduced to the instructions at the level of primary education.

Keywords: Science Education, Astronomical Phenomena, Education Primary School Students' Conceptions, Misconceptions

İLKÖĞRETIM ÖĞRENCİLERİNİN ASTRONOMİ OLAYLARINA İLİŞKİN FİKİRLERİ

ÖZET

Bu çalışmada, bazı temel astronomi olaylarına ilşkin ilköğretim 6. sınıf öğrencilerinin fikirlerinin belirlenmesi amaçlanmıştır. Araştırmanın örneklemini 374 ilköğretim altıncı sınıf öğrencisi oluşturmuştur. Öğrencilerin konuya ilişkin fikirlerini ortaya çıkarmak amacıyla, ilgili literatürden yararlanarak hazırlanan dokuz açık uçlu sorudan oluşan bir "Astronomi Kavram Testi" kullanılmıştır. Benzer anlamlara sahip açıklamalar aynı kategoriler altında yer alacak şekilde, cevapları belli kategoriler altında sınıflandırma yöntemi kullanılarak veriler analiz edilmiştir. Verilerin analizi sonucunda 6. sınıf öğrencilerinin astronomide geçen temel kavramlara ilişkin olarak bir takım kavram yanılgıları olduğu belirlenmiştir. İlköğretim düzeyinde yapılacak öğretim faaliyetlerinde, bu çalışmada ortaya çıkarılan en fazla öğrenci tarafından ifade edilen kavram yanılgıları için kavramsal değişim etkinliklerine yer verilmesi önerilmektedir.

Anahtar Kelımeler: Fen Eğitimi, Astronomi Olayları, Eğitim, İlköğretim Öğrencilerinin Fikirleri, Kavram Yanılgıları

1. INTRODUCTION (GİRİŞ)

A number of studies carried out in different countries for different age groups focused on basic astronomical phenomena (Pfundt & Duit, 2006). Many researchers determined that most of students have misconceptions and difficulties in explaining basic astronomical phenomena (Baxter, 1989; Dove, 2002; Kikas, 1998; Sharp, 1996; Valanides, Gritsi, Kampeza, & Ravanis, 2000; Vosniadou & Brewer, 1992, 1994; Küçüközer, 2007; Parker & Heywood 1998; Trumper 2000, 2001a 2001b; Ünsal, Güneş & Ergin, 2001).

The pioneer studies about astronomical phenomena and concepts were on elemantary school students' conceptions of the Earth (Nussbaum & Novak, 1976; Nussbaum, 1979; Nussbaum & Sharoni-Dagan, 1983). Subsequently, the ideas and misconceptions of pre-school students (Valanides et al., 2000), junior high school students (Baxter, 1989; Dove, 2002; Kikas, 1998; Sharp, 1996; Trumper, 2001a; Vosniadou & Brewer, 1992, 1994), high school students (Baxter, 1989; Lightman & Sadler, 1993), university students (Lemmer, Lemmer & Smit, 2003; Ünsal et al., 2001; Trumper, 2000) preservice teachers (Küçüközer, 2007; Ojala, 1997; Trumper, 2001b) and in-service teachers (Lightman & Sadler, 1993; Mant & Summers, 1993; Parker & Heywood 1998) were investigated. Generally, at the topics that like "solar and lunar eclipse", "seasons", "day and night", "stars", "the phases of the Moon", "the centre of the universe and its dimensions" and "the Solar system, distances and dimensions, Sunrise and Sunset" have been identified conception and misconceptions. Summaries of studies done with the elemantary school students about the some astronomical phenomena are presented below.

- **Eclipses:** Studies suggest that students have difficulties in explaining both eclipses and the roles of shadows of the Earth and the Moon and can not picture the positioning during the eclipses (Barnett & Morran, 2002). Moreover, it has been stated that many students suggested that the Moon must be in the full moon phase during the solar eclipse (Trumper, 2001a; Barnett & Morran, 2002).
- **Seasons:** When studies are reviewed it can be seen that students could not offer the accurate explanation that "seasons occur due to the tilt of the Earth's axis" as successfully as they did for the day and night. Some of the misconceptions, in the literature, on this phenomenon are; "distance to the Sun - when it is closer it becomes summer and when it is farther away it becomes winter-" (Baxter, 1989; Sharp, 1996; Dunlop, 2000; Trumper, 2001a); "changes of the distances between the Earth, the Sun and the Moon" (Trumper, 2001a); "Earth's orbiting the Sun" (Dunlop, 2000); "the Earth faces the Sun during the summer and the Moon during the winter" (Sharp, 1996); "blocking of intensive winter clouds of the Sun light" (Baxter, 1989; Dunlop, 2000); "the moon's position either in front of the Earth or behind it" (Sharp, 1996); "during the summer days the amount of the Sunlight increases" (Dunlop, 2000); "cold planets sour some certain amount of the light coming from the Sun" (Baxter, 1989) and "in order to make it summer or winter the Sun goes to the other side of the Earth" (Baxter, 1989).
- **Day-Night:** Studies on this phenomenon suggest that most of the students offer the accurate explanation that "day and night are results of Earth's rotating on its own axis". On the other hand, in literature most frequent misconceptions on this phenomenon are; "it becomes night because the Sun goes behind the mountains" (Baxter, 1989; Vosniadou and Brewer, 1994); "when the

clouds block the Sun it becomes night" (Baxter, 1989; Vosniadou and Brewer, 1994; Sharp, 1996), "it becomes night when the Moon blocks the Sun" (Baxter, 1989; Sharp, 1996; Dunlop, 2000), "due to the Earth's orbiting the Sun" (Baxter, 1989; Dunlop, 2000; Trumper, 2001a; Dove, 2002) and "due to the Sun's orbiting the Earth" (Baxter, 1989; Dunlop, 2000; Trumper, 2001a).

- **Stars:** In the studies about these subject researchers are mostly interested in comparison of sizes and distances of stars, whether the Sun is a star or not and where the stars are during the daylight. Some of the revealed misconceptions are; "stars do not move" (Dunlop, 2000); "the Sun is not a star" (Sharp, 1996; Dunlop, 2000); "stars are such beings that they only stay during the night at the sky" (Sharp, 1996); "stars are closer to the Earth than the planets are" (Sharp, 1996; Dunlop, 2000); "stars are smaller than the Earth (or the Moon and the Sun) or same size" (Sharp, 1996) and "stars are like the planets" (Dunlop, 2000).
- **The phases of the Moon:** Studies suggest that students have difficulties in explaining the phases of the Moon and can not offer the accurate explanation of "the Moon revolves around the Earth". The most frequent misconceptions, in the literature, on this phenomena are: "the shadow of the Earth (when the Earth comes in front of the Moon it affects the moon's visible part) confusing the eclipse with the phases" (Baxter, 1989; Sharp, 1996; Dunlop, 2000; Trumper, 2001a; Barnett and Morran, 2002); "blocking of clouds of some parts of the Moon" (Baxter, 1989; Sharp, 1996; Dunlop, 2000); "shadow of a planet" (Baxter, 1989), "shadow of the Sun" (Baxter, 1989; Trumper, 2001a) and "during the same day different phases of the Moon can be seen from different cities" (Dunlop, 2000).
- **The center of the universe and its size:** It has been observed by a research about the center of the universe that most of the students offered scientifically acceptable explanation that "the universe has no center" (Trumper, 2001a). On the other hand, some of the students had mis conceptions given below; "the Sun is at the center of the universe" and "the milky way is at the center of the universe" (Trumper, 2001a). About the size of the universe, in a study, most of the students expressed that there was a limit to the boundaries of the universe and some others supposed that the universe was consist of only the Solar System (Dunlop, 2000).
- **Formation of the universe and the solar system:** The numbers of studies conducted at elemantary education level on this subject are quite a few. In a study (Sharp, 1996), it has been suggested that students mostly have ideas far from scientific approach. Same study revealed that students are affected by their religious believes and therefore some students offered the explanation that "the God created everything. First he created Adam and Eve then the Earth and the planets". On hand some others suggested that "millions of years ago everything in the universe was a mass then an explosion took place and it spread around" (Sharp, 1996).

2. RESEARCH SIGNIFICANCE (ÇALIŞMANIN ÖNEMİ)

This study has aimed to determine conceptions of 6^{th} grade students on some basic astronomical phenomena. According to the data gathered through these researches it can be argued that at different countries elemantary students have similar misconceptions on

astronomical phenomena. Although the number of studies on astronomical phenomena and concepts is quite high (Pfundt & Duit, 2006) these kinds of studies are quite new in Turkey (Ünsal et al., 2001; Ekiz and Akbaş, 2005; Bekiroğlu, 2007; Küçüközer, 2007). Only the works of Ekiz and Durmuş (2005) is on elemantary school students in Turkey. The rest has all been conducted on prospective teachers. Therefore, it has been considered that this study will contribute to science education literature Turkish elemantary school students' conceptions about astronomical phenomena.

3. METHODOLOGY (YÖNTEM)

This study is a quantity study that descriptive research technique has been used. The sampling of the study consists of 374 students (ages 11-12) in fourteen classes from five different schools functioning in central Balıkesir (Turkey). An 'Astronomical Concept Test' from now on ACT consists of 9 open ended questions has been prepared by using relevant literature (Barnett and Morran, 2002; Küçüközer, 2007; Lemmer et al., 2003; Trumper, 2001a and Zeilik et al., 1998) in order to reveal 6th grade students' conceptions on basic astronomical phenemena. Day-night, seasons, centre of the universe, stars, shooting Stars, eclipses and phases of the Moon phenomena are included in ACT. Taking into account of views of six physics education specialists, two physics experts and two astronomy experts the content validity of ACT has been realized. The students had been encouraged to answer sincerely each question in ACT before the application. In all the classes it took about 30-40 minutes to complete ACT.

Conceptions of 6th grade students on astronomical phenomena have been found out trough analyzing their answers for each question in ACT. The data have been analyzed by using the technique of putting explanations with similar meanings under the same category. The categorizations were mostly based on conceptions that had been reported in previous studies. Analyzed data is given as tables in results chapter and evaluation of most frequent answers is presented just below the table.

4. RESULTS AND DISCUSSION (BULGULAR VE TARTIŞMA)

- **Seasons:** The question of "what causes the seasons?" was asked to find out the conceptions of students concerning the cause of the seasons. The findings revealed by this question are given in Table 2. As seen in the table, only 5.4% of the students could offer scientifically acceptable explanations that could be placed in the category of 'the tilt on the axis of the Earth' Most of the students in this category explained that "seasons occur due to the tilt on the axis of the Earth (23.5 degree)". Likewise in the literature it is emphasized that the ratio of students who can accurately explain occurrences of the seasons is quite low.

  The most frequent inaccurate explanation category is that 'The Earth revolves around the Sun' with 41.7 percent. Students in this category, mostly offer the explanations that "because the Earth revolves around the Sun seasons occur. I learned this when I was in elemantary school".

Table 1. Conceptions related to the seasons (n=374)
(Tablo 1. Mevsimlere ilişkin fikirler)

Conceptions	f (%)
The tilt of the Earth's axis	20 (5.4)
The Earth revolves around the Sun	156 (41.7)
Explanations based on human (alive, life, Earth)	78 (21.0)
The Earth rotates on its axis	35 (9.4)
Distance from the Sun	24 (6.4)
The Earth revolves around the Sun and rotates on its axis	10 (2.7)
The Sun revolves around the Earth	5 (1.3)
Because of atmosphere	5 (1.3)
Because of eclipses	3 (0.8)
Uncodable	13 (3.5)
No explanation	25 (6.7)

This idea is frequently seen misconception among the students. Students with this misconception mostly pointed previous learning experiences as the source of this view in our study. The ratio of the category of 'explanations based on human (alive, life, Earth)' is quite high to ignore. Explanations of some students in this category are as follows: "the reason of occurrences of the seasons, when it becomes continuously hot arid season takes place humankind can not live in a place like desert. When it becomes cold it becomes extremely cold humans can not be lived in an ice covered place." and "if the seasons do not exist, for example if the ground could not take enough water it could not grow. Therefore, we need seasons that are why they are occurring". Most of the students in the category of 'the Earth rotates on its axis' offered the explanation that because the Earth rotates on its own axis seasons do occur. Students in 'distance from the Sun' category on the other hand stated that "the Earth must be closing up to the Sun and going away from it while it is revolving around the Sun. When it is distant the winter, when it is closer the summer takes place". They have an idea that while the Earth revolves around the Sun it should get closer and go farther away time to time and due to these seasons take place. Many previous studies have pointed out above mentioned misconceptions as well (Baxter, 1989; Sharp, 1996; Dunlop, 2000; Valanides et al.; 2000 Trumper, 2001a).

- **Centre of the Universe:** For the question about the center of the universe students were asked to choose one of the following options "the center of the universe is the Earth", "the center of the universe is the Sun", "the center of the universe is the galaxy of milky way" and "there is no center of the universe" and to explain the reason of their choice. The findings obtained from this question are given in Table 3.

  As seen in the Table 3 almost half of the students marked the right option that is there is no center of the universe. A great many of these students expressed that we can not talk about the center of the universe because it is endless. Some others on the other hand stated that the center of the universe can not be known since we do not exactly know the size of the universe or because the universe is expanding. The explanations of the students who marked the option say that the Sun is the center of the universe were categorized in three groups. Students in the category of 'the Sun is the source of life' mostly told that if the Sun were not existing there would be no life on Earth. The Sun is our source of life, it warms up and lights the Earth.

Students in the category of 'the Sun is in the center and all the planets revolve around the Sun' offered such explanations that 'all the planets revolve around the Sun.

Table 2. Conceptions related to the Centre of the Universe (n=374)
(Tablo 2. Evrenin merkezine ilişkin fikirler (n=374))

Conceptions	f (%)
The Universe does not have a center in space	
- The Universe is endless	103 (27.5)
- We do not exactly know the size of the universe	28(7.5)
- Expanding of the universe	10(2.7)
- Uncodable	12(3.2)
- No explanation	32(8.6)
Total	185(49.5)
The Sun is at the center of the Universe	
- The Sun is the source of life.	32 (8.6)
- The Sun is in the center and all the planets revolve around the Sun	22 (5.9)
- The Sun lights and heats the entire universe.	19 (5.1)
- Uncodable	7 (1.9)
- No explanation	16 (4.3)
Total	96 (25.8)
The Earth is at the center of the Universe	
- There is life on the Earth.	40 (10.7)
- Uncodable	11 (2.9)
- No explanation	17 (4.6)
Total	68 (18.2)
The Milky Way Galaxy is at the center of the Universe	
- All stars and planets we see are in the Milky Way galaxy	4 (1.1)
No Response	17 (4.6)

The Sun is at the very center that is why the center of the universe is the Sun'. In the category of 'it lights and heats the entire universe' students offered such an explanation that "the source of the energy of the universe is the Sun. It lights and heats the entire universe therefore the Sun is the center of the universe'. 18.2% of the students marked the option that is the Earth is at the center of the Universe. Most of the students offered explanations that could be placed in the category of 'there is life on Earth'. Explanations of those students are mostly like "because there is no life anywhere else in the universe the Earth is the center of the universe". Misconceptions obtained about the center of the universe have been revealed by other studies conducted on elemantary school students as well (Trumper, 2001a; Dunlop, 2000).

- **Formation of the Universe:** It was the aimed to find out the conceptions of the students on the formation of the universe by asking the question 'what do you think about how the universe was formed'. The findings obtained through this question are given in the Table 4. As seen in the Table 4, 11.2% of the students offered scientifically acceptable explanations in the category of 'big bang'. These explanations are mostly like the examples: "by the explosion called big bang the universe was formed, I have read this in a journal" the sizethe of the

universe was something like a top of a needle, a massive explosion took place and then it was expanded" and "I have watched somewhere, scientists have proved that the universe was formed by the big bang". Among the other categories, the category of 'religious explanations' has the highest ratio (18.2%). In this category most of the students stated such views that: "in my opinion the universe was created by Allah (God)" and "to test the humans Allah created the universe". Such religious explanations have been revealed by the study conducted by Dunlop (2000).

Table 3. Conceptions related to the formation of universe (n=374)
(Tablo 3. Evrenin oluşumuna ilşkin fikirler)

Conceptions	f (%)
Big Bang	42 (11.2)
Religious explanations	69 (18.2)
It was formed together the planets and stars	32 (8.6)
It was formed as a result of explosion of pressured gases	26 (7.0)
it was formed as a result of coming together of gases and dust particulars	23 (6.2)
Exploding of a colossal mass	21 (5.6)
Un-known	17 (4.6)
It was spontaneously formed	15 (4.0)
Formed by the explosion of the Sun	14 (3.7)
The universe has always existed, and it will exist forever.	8 (2.1)
Formed by fractures that broke off from the Earth	9 (2.4)
Uncodable	52 (13.9)
No explanation	46 (12.3)

In the categories of 'It was formed as a result of explosion of pressured gases ', 'it was formed as a result of coming together of gases and dust particulars', 'Exploding of a colossal mass', 'formed by the explosion of the Sun' and 'formed by fractures that broke off from the Earth' students assume that there were some things like gases, a colossal mass, Sun and Earth and somehow something happened to them and as a result the universe was formed. In the literature similar misconceptions were found out by Dunlop (2000).

- **Day-Night Cycle**: To find out the conceptions of students on the reasons for the occurrence of the day-night cycle the question of "what do you think what causes the Day – Night Cycle?" was asked. As seen in Table 1, 60.4% of students gave acceptable explanation that "the rotation of the Earth on its own axis causes day and night". In the category of 'explanations based on human (alive, life, Earth) ' such ideas are dominant that day and night are present for humankind, live beings and the Earth if they do not exist day and night would not exist at all. For example some explanations: "like if it was always daytime human could not get any sleep, if it was always night they would not wake up at all. In my opinion, it is because for the balance of the Earth" and "if there was not day and night in my opinion there would be no life. For example if human kind did continuously experience daylight it would be a little nonsense I mean". In the literature it is the first time to come across this misconception as far as we know. However, a similar category was revealed by Valanides et al. (2000) among younger age group (5-6).

Table 4. Conceptions related to the Day-Night (n=374)
(Tablo 4. Gece-Gündüze ilişkin fikirler)

Conceptions	f (%)
The Earth rotates on its axis	226 (60.4)
Explanations based on human (alive, life, the Earth)	60 (16.0)
The Earth revolves around the Sun	29(7.8)
The Sun revolves around the Earth	18 (4.8)
Those who show the Moon as the reason	8 (2.1)
Distance from the Sun	7(1.9)
Because of the Erarth' shape	4 (1.1)
The Earth, the Moon and the Sun always move	3 (0.80)
Uncodable	9 (2.4)
No explanation	10 (2.7)

In categories 'the Earth revolves around the Sun' and 'the Sun revolves around the Earth' students' explanations that day and night occurs because either the Earth revolves around the Sun or the Sun revolves around the Earth. Such misconceptions were discovered by earlier works as well (Baxter, 1989; Dunlop, 2000; Trumper, 2001a). In the category of 'those who show the Moon as the reason' students offers such explanations that "due to the revolving of the Earth around the Moon day-night occurs" or "if the Moon comes before the Earth it becomes night, and if it stops blocking the Sun it becomes daytime". Similar misconceptions were revealed by Baxter (1989), Sharp (1996) and Dunlop (2000) too.

- **Stars and the brightest star:** The question of "where are the stars during the day?" was asked to discover the conceptions of students about the stars. Table 5 presents students' conceptions on the stars. Most of the students gave an explanation in the category of "at the same place". They mostly made the explanation of "at the same place but during the day due to the Sunlight they cannot be seen".

Table 5. Conceptions related to the stars (n=374)
(Tablo 5. Yıldızlara ilişkin fikirler (n=374))

Conceptions	f (%)
At the same place.	256 (68.4)
Due to clouds we cannot see them during the day	32 (8.6)
They are on the dark side of the Earth	31 (8.3)
Stars reflect Sunlight as planets	22 (5.9)
They are at anywhere in daytime, but they appear when it becomes dark	12 (3.2)
They are at sky all the time, but they go on at night while go off at daytime	5 (1.3)
Uncodable	8 (2.1)
No explanation	8 (2.1)

In the category of 'due to clouds we cannot see them during the day', students made the following explanation that, "they are seen when it becomes night, during the day, on the other hand, due to clouds they are not seen. Because clouds prevent them from being seen". Students in this category suppose that the stars are seen during the night because there are no clouds then, but during the day due to clouds they are not seen. In the category of 'they are on the dark side of the Earth', students made the explanations that "Because the Earth is spinning we can not see during the day. When it becomes dark they appear" or

"they are on the dark side (night side) of the Earth". Similar misconceptions have been seen among older students as well (Lemmer et al., 2003). In the category of "stars reflect Sunlight like planets do", students made the following explanations that "the stars are like the planets they are seen during the night, they reflect the Sunlight" or "they are in the sky but we cannot see them during the day because they do not generate light themselves. They only reflect light coming from the Sun during the night". This misconception has similarities with the conception of 'stars are similar to planets' revealed by Dunlop (2000). As students, in this study, stated that stars look like planets, and they reflect the light coming from the Sun as well.

In order to discover the conceptions of students about the brightest star students were asked that in a clear summer evening if they were somewhere off the city away from the city lights and air pollution what the brightest object would be in the sky. Following their answer they were asked to explain their answers. Table 7 presents students' conceptions on the brightest star. As seen in Table 7 only one student offered an explanation that could be scientifically acceptable. The student told that "a star called Vega. I have heard this somehow I do not remember exactly, I might have also read". In reality, the brightest star that can be seen in the Earth's sky is Sirius. This star, together with the second and third brightest stars, is the stars that are usually seen in the Southern Hemisphere. The brightest stars in the Northern Hemisphere are Arctrus, and then Vega. Arctrus is not in its Main Star Sequence at this time but is in its Red Giant stages. Because of this, the brightest star that students can see from where they are at night is Vega. This is why we can accept the response of "Vega" as correct (if students gave Sirius and Arcturus answers, they would accepted correct).

Table 6. Conceptions related to the brightest star (n=374)
(Tablo 6. En parlak yıldıza ilişkin fikirler (n=374))

Conceptions	f (%)
Vega	1 (0.27)
The Pole star (Polaris)	220 (58.8)
The Shepherd star (Venus)	50 (13.4)
The Moon	23 (6.2)
The nearest star	20 (5.4)
Comet	15 (4.0)
Brightness of all stars is the same	10 (2.7)
Uncodable	16 (4.3)
No explanation	19 (5.1)

Among the inaccurate explanations 'Polaris' category is the one in which the most wrong answers of the students have been placed. Most of the students in this category used such explanations that: "it helps us to find our direction, it is a very bright star, that is why it is the brightest star in the sky our elemantary school teacher told us this" or "because Polaris always shows the north it is the brightest star". Most of the students stated that they had the information that the brightest star in the sky is Polaris from their elemantary school teachers. It can be accordingly concluded that this misconception might be sourced of their teachers. In the category of 'Shepherd Star' most of the students told that "it

is the Shepherd star, my father (or mother, elder brother and sister etc.) has told me so. As a matter of fact, that it is very big and very bright". Students in this category, in fact, were talking about not a star but a planet called Venus known as the Shepherd star or morning star among ordinary people in Turkish language. If it has not been disappeared yet Venus, in fact, is the brightest object after the Moon in the sky. Students told that the brightest star was shepherd star because of their lack of knowledge of the differences between stars and planets and calling of Venus as the Shepherd star or morning star in everyday use. In the category of 'the Moon' students answered that "because it is the biggest star I say it is the Moon" or "it is because the brightest is the Moon". As far as we know such a question has not been asked so far in a study conducted on elemantary school students. Therefore, all the misconceptions among the wrong answers have been revealed for the first time.

- **Shooting Stars:** The question of "in a clear night while watching the sky, Ahmet screamed with an excitement 'a star glided!' What do you think Ahmet meant by saying 'a star glided?" was asked to discover the conceptions of students about the shooting stars. Table 8 presents students' conceptions on the shooting stars. Only 9.1% of the students offered explanations in the category 'moving of a meteor in the Earth's atmosphere' that could be considered accurate. Explanations in this category are mostly like as: "shooting star is an event of burning of a meteorite which has fallen into the Earth's atmosphere" or "it is burning of a meteorite which has gone out off its orbit".

Table 7. Conceptions related to the shooting stars (n=374)
(Tablo 7. Yıldız kaymasına ilşkin fikirler)

Conceptions	f (%)
Moving of a meteor in the Earth's atmosphere	34(9.1)
The shooting star considered as an event related to the stars	229(61.2)
Dying of someone or taking a wish - superstition	34 (9.1)
Comet	7 (1.9)
Uncodable	23 (6.2)
No explanation	47 (12.6)

In the category of 'the shooting star considered as an event related to the stars', more than half of the students explained the event as having something to do with the stars. They explained mostly their responses with the following statements: "shooting star is changing places of stars by their movement in space", "it is falling of a star which has lost its energy towards the Earth", "stars remain at the same place because the Earth is spinning we see them as if they are gliding" or "shooting star is its explosion when its time has come to an end". In the category of 'dying of someone or taking a wish - superstition', students made explanations according to their daily life experiences and knowledge, they have obtained from people around them or from movies. It is possible to consider these explanations as superstitions. Some of these accounts are as follows: "when a star has glided over it means that someone has just died, my uncle told me this. A wish is taken as well, but I do not understand why", "I have watched in a movie people were dying when a star had glided" or "it is said that someone has just died when a star glides, a wish is taken as well". In

the category of 'comet' students mostly offered the explanation that "shooting star is an event of disappearing of a comet". Within the knowledge of this study such a question has not been asked in any study which has been conducted on elemantary school students so far. Therefore, all the conceptions exist in the inaccurate explanations in this study have been revealed for the first time amongst elemantary school students. Only Küçüközer's (2007) study with prospective science teachers has revealed similar misconceptions under the category of 'the shooting star considered as an event related to the stars'.

- **Moon Eclipse:** In order to discover the conceptions of students about the Moon eclipses students were asked to explain with a diagram what they understand from the term the 'the Moon eclipse'. Table 8 presents students' conceptions on the Moon eclipse. As seen in the table about one third of the students' explanations was accurate and could be placed in the category of 'the Earth moves between the Sun and the Moon and the Moon can not be seen'. In this category students mostly explained that "the Earth goes between the Moon and the Sun and the shadow of the Earth prevents the Moon from being seen".
'Confused with the solar eclipse' and 'the Sun's entering between the Earth and the Moon' categories have the most frequent wrong answers. In the former students confused the lunar eclipse with the solar one. In the latter students suppose that the lunar eclipse takes place as a result of coming the Sun between the Earth and the Moon. It shows that students in this category have a difficulty on sizes, since they suppose that the Sun can move into the space between the Earth and the Moon.

Table 8. Conceptions related to the Moon eclipse (n=374)
(Tablo 8. Ay tutulmasına ilişkin fikirler (n=374))

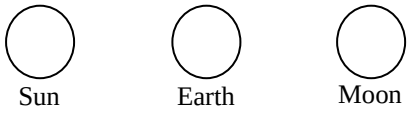
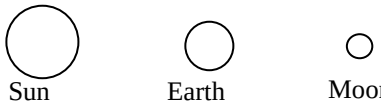
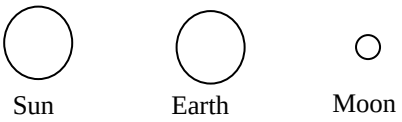
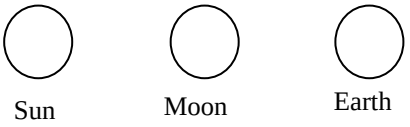
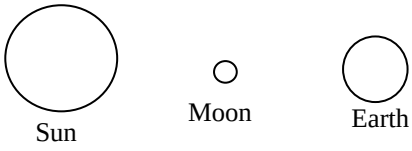
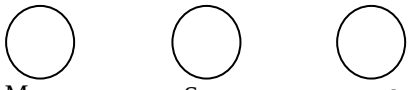
Conceptions	f (%)
The Earth moves between the Sun and the Moon and the Moon can not be seen	120 (32.1)
Confused with the solar eclipse	92 (24.6)
The Sun's entering between the Earth and the Moon	69 (18.5)
Confused with the Phases of the Moon	17 (4.6)
The Moon stands still	10 (2.7)
The Moon goes through the behind of the clouds at awhile then appears again	10 (2.7)
A planet's (or a star) entering between the Earth and the Moon	7 (1.9)
Uncodable	21 (5.6)
No explanation	28 (7.5)

The diagrams of the students about the lunar eclipse are given in Table 9. These diagrams are grouped under three basic categories called A, B and C. Category A is divided into three and category B is divided into two more sub-categories. Category A consists of diagrams that accurately put the Sun, the Earth and the Moon on the right order. The rest on the other hand consists of inaccurate drawings. In category B some students draw the Sun - the Moon - the Earth confusing with the solar eclipse while in category C the others put the Moon first and then the Sun and the Earth next to each other.
When we look at the categories in more detail, we see that although in category A the order is right the distances and the sizes are wrong in all three sub-categories. In category A1 the sizes of the Sun, the Earth and the Moon and the distances

between them are equal drawn while in sub-category A3 only the size of the Moon is drawn smaller than of the Earth and the Sun again the sizes of the Earth and the Sun and the distances between them are equal drawn. Sub-category A2 consists of relatively accurate drawings compare to of A1 and A3 sub-categories. In this category the sizes are drawn respectively accurate but the distances between the Sun, the Earth and the Moon are again equal drawn. In the category B the order of the objects during the supposed lunar eclipse is inaccurately drawn. A drawing in B1 sub-category shows the sizes and the distances equal as they were in sub-category A1. B2 sub-category includes the drawings that show the distances relatively accurate like in the A2 sub-category but the sizes are shown inaccurately in this category. In category C drawings that show an impossible positioning of the Sun between the Earth and the Moon are included. Drawings in this category also show the distances and the sizes equal. Similar drawings also can be seen in Bakas' and Mikropoulos' (2003) works.

The question on "the diagrams given above show the Moon's appearance on any one night and a couple of nights after that night. What do you suppose what could be the reason for this change?" was asked to discover the conceptions of students about the phases of the Moon. Table 10 presents students' conceptions on the phases of the Moon. As seen in the table 8.6% of the students offered scientifically acceptable explanations that could be placed in the category of 'the Moon revolves around the Earth'. Students in this category mostly told that "*the phases of the Moon occur since the Moon revolves around the Earth*". Among the wrong answers the most frequent ones are in the category of 'phases of the Moon confused with the lunar eclipse'. Explanations of the students in this category are mostly as follows: "*The Earth has come between the Moon and the Sun, in time it moves away and the Moon is seen more and more*" or "When *lunar eclipse has taken place, a couple of nights after the Earth moves away from its position between the Moon and the Sun the Moon is seen more and more*". Since students do not have the knowledge that lunar eclipse lasts only a couple of hours in a single night they think that the changes in the appearance of the Moon within a couple of nights occur due to lessening of the Earth's shadow on the Moon as a result of the change of the Earth's position between the Sun and the Moon. This conception is often seen in the literature as well (Baxter, 1989; Dunlop, 2000; Trumper, 2001a; Barnett & Morran, 2002).

Table 9. Students' diagrams about the Moon eclipse
(Tablo 9. Ay tutulmasına ilişkin öğrencilerin çizimleri)

	Diagrams	f (%)
A: The right order but dimension and/or distances are wrongly drawn	A1: Dimension and distances are shown to be equal 	62 (16.6)
	A2: Dimensions are partially drawn correctly but distances are shown to be equal 	43 (11.5)
	A3: Dimensions of the Sun and Earth are shown to be equal and all distances also are shown equally 	35 (9.4)
B: Confused with the solar eclipse	B1: Dimension and distances are shown to be equal 	78 (20.9)
	B2: Dimensions are partially drawn correctly but distances are shown to be equal 	42 (11.2)
C: The Sun's entering between the Earth and the Moon	Dimension and distances are shown to be equal 	78 (20.9)
No diagram	----	36 (9.6)

The phases of the Moon

One night

A few nights later

The question on "the diagrams given above show the Moon's appearance on any one night and a couple of nights after that night. What do you suppose what could be the reason for this change?" was asked to discover the conceptions of students about the phases of the Moon. Table 10 presents students' conceptions on the phases of the Moon. As seen in the table 8.6% of the students offered scientifically acceptable explanations that could be placed in the category of 'the Moon revolves around the Earth'. Students in this category mostly told that "the phases of the Moon occur since the Moon revolves around the Earth". Among the wrong answers the most frequent ones are in the category of 'phases of the Moon confused with the lunar eclipse'. Explanations of the students in this category are mostly as follows: "The Earth has come between the Moon and the Sun, in time it moves away and the Moon is seen more and more" or "When lunar eclipse has taken place, a couple of nights after the Earth moves away from its position between the Moon and the Sun the Moon is seen more and more". Since students do not have the knowledge that lunar eclipse lasts only a couple of hours in a single night they think that the changes in the appearance of the Moon within a couple of nights occur due to lessening of the Earth's shadow on the Moon as a result of the change of the Earth's position between the Sun and the Moon. This conception is often seen in the literature as well (Baxter, 1989; Dunlop, 2000; Trumper, 2001a; Barnett & Morran, 2002).

Table 10. Conceptions related to the phases of the Moon (n=374)
(Tablo 10. Ayın fazlarına ilşkin fikirler (n=374))

Conceptions	f (%)
The Moon revolves around the Earth	32 (8.6)
The phases of the Moon confused with the Moon eclipse	120 (32.1)
Getting closer of the Sun to the Moon	65 (17.4)
Four phases of the Moon have been explained	41 (11.0)
The Sun has come between the Moon and the Earth, when the Sun goes off between them, the Moon more visible	20 (5.4)
The weather condition (cloudy or foggy)	18 (4.8)
Uncodable	23 (6.2)
No explanation	55 (14.7)

In the category of 'getting closer of the Sun to the Moon' students mostly offered the explanation that "*the Sun is getting closer to the Moon, the Moon surface receives more beams than usual and more beams are reflected as a result*". Students in this category show the Sun's getting closer to the Moon as a reason of increasing the bright parts of the Moon. In the category of 'four phases of the Moon have been explained' considering the Moon itself as the reason of the changes in its appearance most of the students told that "*the Moon has the phases, new moon, full moon, first quarter, last quarter and the crescent, the moon shows these phases of itself every month*". The misconceptions of 'getting closer of the Sun to the Moon' and 'four phases of the Moon have been explained' have not been seen in any other research done with elemantary school students within our knowledge.

5. CONCLUSION AND SUGGESTIONS (SONUÇ VE ÖNERİLER)

In this study it has been attempted to discover the conceptions of elemantary school students on astronomical phenomena. While this study corroborates previous researches concerning ideas and misconceptions it also sheds light on some new misconceptions along with those that are commonly known in literature. These conceptions

are "The shooting star considered as an event related to the stars", "shooting star, means someone has just died and a wish is taken - superstition", "shooting star is disappearance of a comet", "the brightest star is Polaris in the sky (or the Shepherd star-Venus-, the Moon, comet)", "phases of the Moon occur due to getting closer of the Sun to the Moon" and "the phases of the Moon are characteristics of the Moon. The Moon shows these phases every month". It has been discovered for the first time that this age group has "human (live being, life, the Earth) based" explanations for day-night and seasons though it has been revealed earlier that younger generation has this misconception (Valanides *et al.*, 2000). The findings show that elemantary school students have some misconceptions on several basic astronomical phenomena. Therefore, in science classes during the teaching of astronomy subjects conceptual change activities should be included. Moreover, the concepts of which most of the students have difficulties in explaining accurately such as seasons, formation of the universe, eclipses and phases of the Moon should be especially emphasized on. In order to make students able to comprehend these phenomena more easily three dimensional models instead of two should be employed and teaching should be supported by plenty of photos, pictures and diagrams (Barab, Hay, Barnett & Keating, 2000; Hansen, Barnett & MaKinster, 2004; Parker & Heywood, 1998). For the shooting stars, activities enabling students to understand that shooting stars have nothing to do with stars should be organized. In order to show students the brightest star and have them understand it is Vega they should be taken out to observe it in a night and to explain the differences between the stars and planets observation activities with a telescope should be realized.

As regard to eclipses, the diagrams drawn by the participants show that they did not pay attention to the sizes of the Sun, Earth, and moon, or to the distances between them. They generally pointed out their textbooks and teachers as being responsible for this. When one looks at elemantary school textbooks it easily can be seen that it is true they do not take into consideration of the relative sizes and distances (Küçüközer, 2007). Necessarily it can easily be argued that usage of three-dimensional diagrams and animations, instead of two-dimensional ones, has become a requirement in instruction on astronomy (Barab *et al.*, 2000; Hansen *et al.*, 2004; Parker & Heywood, 1998).

Almost one-fifth of the students offered religious explanations for the formation of the universe. In a scientific question, they used their religious knowledge to answer the question. Teachers should be careful while teaching the formation of the universe since students might naturally have religious views about the subject and confrontation between the scientific evidence and their religious ideas might result in further conceptions. Teacher, in this case, should present the scientific facts and evidences and tell students that in a science class it is not their responsibility to go into religious discussions.

NOTICE (NOT)

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