REPUBLIC OF TURKEY

YILDIZ TECHNICAL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

REVEALING MIDDLE SCHOOL STUDENTS' MISCONCEPTIONS ABOUT BASIC ASTRONOMY CONCEPTS THROUGH DRAWING METHOD

Ece Ebrar KOCA

MASTER THESIS

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Advisor

Prof. Dr. Bayram COŞTU

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A thesis submitted by Ece Ebrar KOCA in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE is approved by the committee on 06.11.2019 in Department of Mathematics and Science Education

Prof. Dr. Bayram COŞTU

Yildiz Technical University

Advisor

Approved By the Examining Committee

Bayram COŞTU
Yildiz Technical University _____

Hakan AKÇAY
Yildiz Technical University _____

Mehmet Cihad AYAR
Istanbul Aydin University _____

I hereby declare that I have obtained the required legal permissions during data collection and exploitation procedures, that I have made the in-text citations and cited the references properly, that I haven't falsified and/or fabricated research data and results of the study and that I have abided by the principles of the scientific research and ethics during my Thesis Study under the title of Revealing Middle School Students' Misconceptions about Basic Astronomy Concepts through Drawing Method supervised by my supervisor, Prof. Dr. Bayram COŞTU. In the case of a discovery of false statement, I am to acknowledge any legal consequence.

Ece Ebrar KOCA

Dedicated to my family

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ACT	Astronomy Concept Test
CP	Cut-Off Point
MEB	Ministry of Education
POE	Prediction-Observation-Explanation
TTK	Turkish Education Board
WAT	Word Association Test
YÖK	Council of High Education

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Revealing Middle School Students Misconceptions about Basic Astronomy Concepts through Drawing Method

Ece Ebrar KOCA

Department of Science Education

Master of Science Thesis

Advisor: Prof. Dr. Bayram COŞTU

The main purpose of this study is to reveal middle school students' misconceptions about basic astronomy concepts. The study was conducted in a public school in Gaziantep. The study was carried out with 181 middle school students. The students were from six different classes. Each of two classes was from 6^{th}, 7^{th} and 8^{th} grades, respectively. A hundred of the students were female and the others were male. This study is based on a qualitative research method. In this research method, students were asked questions about basic astronomy concepts and were asked to answer these questions by drawing. After the students' drawings, interviews were also utilized in order to clarify students' drawings and to probe students' understandings. According to the results of the study, a wide variety of misconceptions about astronomy concepts were revealed. The main findings showed that students have lack of knowledge about sizes of the Earth and moon, how the solar and lunar eclipses take places, celestial bodies in the eclipses and difficulty about vitalization of the eclipses in their minds.

Key Words: Basic astronomy concepts, drawing method, misconceptions, science education

ÖZET

Ortaokul Öğrencilerinin Temel Astronomi Alanındaki Konularla İlgili Kavram Yanılgılarının Çizim Yöntemiyle Belirlenmesi

Ece Ebrar KOCA

Fen Bilgisi Bölümü

Yüksek Lisans Tezi

Danışman: Prof. Dr. Bayram COŞTU

Bu çalışmadaki asıl amaç fen bilimleri dersinde yer alan temel astronomi konularındaki ortaokul öğrencilerinin sahip oldukları kavram yanılgılarını ortaya çıkarmaktır. Çalışma Gaziantep Türkiye'deki bir devlet okulunda gerçekleştirilmiştir. Çalışma iki 6.sınıf, iki 7. sınıf ve iki 8.sınıf olmak üzere toplam altı sınıfta, 181 sayıda öğrenciyle gerçekleştirilmiştir. Öğrencilerin 100'ü kız, diğerleri ise erkektir. Çalışma kapsamında öğrencilere astronomi konuları ile ilgili sorular sorulmuş ve cevaplarını çizerek ifade etmeleri istenmiştir. Çalışma nitel bir çalışmadır. Çalışmada öğrencilerin temel astronomi konularındaki kavram yanılgılarını çizim yöntemiyle tespit etmek amaçlanmıştır. Öğrencilerin çizimlerinin ardından, çizimlerini netleştirmek ve öğrencilerin anlamalarını sorgulamak için görüşme verilerinden yararlanılmıştır.

Öğrencilerin çizimlerinde ayın dünyadan daha büyük, dünyanın aydan daha büyük olduğunu ifade eden çizimlere; güneş tutulmasıyla ay tutulmasını birbirine karıştırdıklarına, tutulmalarda yer alan gökcisimlerini tam olarak bilmediklerine ve de tutulmaların nasıl gerçekleştiğini zihinlerinde canlandıramadıkları ve çizimlerine yansıtamadıkları sonucuna ulaşılmıştır.

Anahtar Kelimeler: Temel astronomi konuları, çizim yöntemi, kavram yanılgıları, fen eğitimi

1
Introduction

1.1 Literature Review

Education has a great importance for nations especially for the developed and developing ones. In order to keep up with the developments in the 21st century, developing individuals themselves has a vital role. The development of societies is only possible with qualified and competent individuals. In order to have such citizens, a nation should have a qualified educational system. For this reason, countries change their educational systems and curriculums frequently. For instance, in Turkey, educational system changed into 4 + 4 + 4 to improve the education in our country and some changes were done in the science curriculum. With the changes of science curriculum in 2018, the topic of astronomy have gained more attention and involved in each grade's science curriculum as a first unit [1].

When we examine the previous science curriculum, the order of the unit about astronomy changed from the last units to the first ones, which can be seen an important step. Learning is the fact that the existing information reaches to a whole by associating the information obtained as a result of experiences [2]. The events, facts and concepts that individuals or students face during their lives and experiences constitute the knowledge of a person. Furthermore, experiences make the knowledge more meaningful. In order to provide sound understanding, it must be learned without the mistakes and misconceptions. For the meaningful learning to be fully realized, the existing knowledge of the students, which is the most important factor affecting learning according to Ausubel, should be revealed and new learning should be based on this . The most important factor preventing the scientifically meaningful learning is to have preconceived knowledge or misconceptions that individuals have gained through various experiences [3]. Nonscientific concepts, not accepted by scientific community, are called as misconceptions. In the relevant literature misconceptions called as different terms such as preconceptions, alternative concepts, children science, spontaneous knowledge and so on [3].

1.2 Importance of the Science Courses

One of the main goals of education is to prepare individuals for life and to enable them to give meaning to the events taking place in a daily life. Science is very important in the fulfillment of these basic objectives because science is one of the most important tools for students to understand nature and relations in nature. In this context, the science course affects our daily life and has main effects in our lives. This is all to say, *science is the life itself*.

The science course is one of the easiest lessons to relate to everyday life. The usage of many technological developments in a daily life and the functioning of natural laws constitute the contents of science course. Rather than memorization, learning by grasping, problem solving and scientific process skills are the courses involved by the science course [4].

The aim of science education is to effectively answer the questions that children and young people ask about nature and facilitating the adaptation of individuals to a constantly evolving and changing society [5]. One of the most important objectives of the science education is to educate each individual as a scientifically literate person. Scientifically literate people have problem solving skills, critical thinking ability, self-confidence, good communication skills, and are conscious about sustainable life and lifelong learners [6]. The positive attitudes of students towards science affect their scientific thinking, scientific problem solving, and their achievement in science courses [7]. It was found that students with high motivation have higher levels of learning and the knowledge that they learn remains longer in their memory [8]. Another aim of science education is to encourage individuals to keep up with the developing society [9].

Through the science course, students try to find answers to the problems related to their daily life by performing various investigations and learning through their own experience. These provide permanent and meaningful.

1.3 Place of Astronomy in Science Education

Humans have been watching and probing the sky for many years. With the help of technological developments, the sky now to be watched with the telescopes. Countries

try to learn about space and the universe by making billions of dollars of investments. Studies to probe space and celestial bodies allow us to get to know about the planets such as the earth. Since the existence of ancient civilizations, astronomy provides important steps for human development. Many developments in the field of astronomy have facilitated our lives in the world. Astronomy, involving a large number of abstract concepts, has an important place in science education because of its relation with the world, nature, and a variety disciplines such as mathematics, physics, chemistry and biology [10].

Astronomy is a science, which is very important for the development of nations and self-realization. With the astronomy education, many young individuals are becoming more and more interested in astronomy with the excitement of the existence of celestial bodies in the universe. Astronomy subjects in the science course are one of the subjects that attract the attention of individuals and are among the most curious subjects. As a result of the researches, it was stated that the most curious subjects for primary school students and the subjects they wanted to learn were astronomy concepts.

Astronomy is one of the oldest and most fundamental sciences [11]. It is associated with different disciplines such as physics, chemistry, mathematics, geology, and meteorology [12]. For this reason, the science curriculum in the Turkish education system involves the subjects of astronomy from primary to higher education. In our country, basic astronomy subjects have been taught from the 3rd grade level to the secondary level [1]. Bailey and Slater [11] stated that although there are many studies in the field of astronomy education, studies on this subject are still very limited.

One of the main aims of science education is to change the students' non-scientific understanding, namely the misconceptions, towards the scientific ones [13]. Therefore, firstly, students' misconceptions have to be revealed. From this point of view, astronomy education has a great importance at all levels of schooling. Astronomy, involving a large number of abstract concepts, has an important place in science education because of its relation with the world, nature, and a variety disciplines such as mathematics, physics, chemistry and biology [10]. The relation of astronomy with other sciences was given in Figure 1.1.

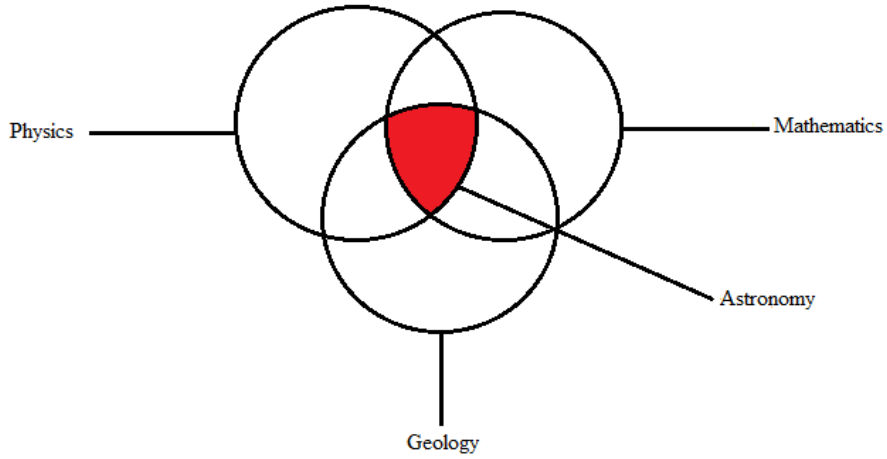

Figure 1.1 The Relation of Astronomy with Other Sciences

According to the study by the Ministry of National Education's (MoNe) and Turkish Education Board (TTK), there are fewer concepts and units related toastronomy in Turkisch science curriculum than the other countries [14].

Astronomy subjects are generally the ones which science teachers do not have sufficient conceptual knowledge and they don't find themselves adequately successful about it. As a result, astronomy topics have not been studied in depth. When the general aims of Astronomy and Space Sciences course are examined, the relation between Science and Astronomy can be seen very clearly.

In addition, astronomy science has various purposes in line with its specific concepts. These purposes;

1. To develop a positive attitude towards the science of astronomy,

2. To teach how to solve some problems encountered in daily life in terms of basic astronomy sciences,

3. To apply the problem solving skills acquired in mathematics and physics to the physical phenomenon,

4. To teach historical development of astronomy science,

5. To gain scientific research experiences and to develop science process skills,

6. To develop creativity and scientific thinking skills,

7. To develop three-dimensional thinking abilities,

8. To understand the relationships between time, position and numbers,

9. To teach rapid technological developments in astronomy and how they interact with basic sciences,

10. To gain realistic and scientific ideas about extraterrestrial life and events [15].

1.4 The Importance of Astronomy

Children should understand the scientific explanations, answer the questions, and understand how the natural world works and become aware of the different tools that enable them to understand the world [16]. In accordance with the goals of science education, the lessons in astronomy should encourage and allow children to ‘‘develop effective ways of learning through enquiry’’ in order to understand the nature, the strengths and limitations of astronomical enquiry [17].

Increasing space research and studies in the globalizing world and the country's leading race in these areas lead to an increasing importance of astronomy. The increasing number of satellites and space shuttles in space research that attracted much attention of many people to astronomy [18].

According to Trumper [18], the benefits of astronomy are indicated as follows:

1. Informing students about the developments in astronomy arouses their interest and increases students' motivation to learn science,

2. Studies about the other science disciplines can be enriched by astronomy,

3. As a discipline, astronomy can prove that abstract knowledge can be represented by concrete data that can be explained and scientific knowledge can change.

1.5 What is Misconception?

Misconception is a term that students develop mentally as different from scientifically accepted idea or opinion. The students form their own thoughts and views about the events due to the interactions with the natural world before taking formal science education [19]. Most of the views students have acquired from their experiences is

mostly far from scientific facts and includes unscientific beliefs and this causes alternative views, namely misconceptions. Misconceptions are entitled in many ways in the literature. Misconceptions, preconceptions, alternative concepts, childrens' science, or spontaneous information can be given as some examples [3]. When people encounter the same situation or information, each creates different ideas depending on their own experience and knowledge [20]. Students relate their newly learned knowledge with the existing one and constructed them in their minds [21]. Therefore, any deficiencies in the prior knowledge of the students may lead to misunderstanding [22]. Trumper, in his study, argues that some subjects are not well taught or mis-taught in schools because teachers have misconceptions, too [23].
It is also possible to say that teachers are also main source for misconceptions. Misconceptions are quite resistant to change and affect learning negatively [24].

Children may hold misconceptions at any age or educational level. There are many reasons for misconceptions given in the literature. Some of these reasons may include personal experiences, gender, conversations between peers, media, language and laboratory studies, and even textbooks [25]. In addition, unsuitable teaching methods and materials may cause misconception [26]. In earlier studies in the literature, it was stated that most of the primary school teachers were inadequate especially in the knowledge of astronomy. It was also reached that the concepts of astronomy were not taught by instructional techniques suitable for the students' mental development and as a result, students had difficulty in understanding astronomy subjects. In addition, it was observed that prospective science teachers developed many misconceptions related to astronomy concepts and they were not self confident even they had the correct answers to the questions [27].

Studies have showed that elementary school students, university students and even teachers have basic misconceptions about fundamental astronomy subjects that are related to real life. Many studies show that students have various misconceptions about astronomical events [28]. According to the results obtained from relevant studies, alternative concepts or misconceptions have negative effects on the learning of new knowledge of students. In this context, further studies should be done to change students' misconceptions towards scientific ones. It is important and necessary to determine the misconceptions that students have and the learning activities should be

organized with their status. Looking at the relevant literature, it was found that the students from different grades have many and various misconceptions related to the astronomy concepts. According to the literature, it was reached that teachers, prospective teachers and students have lacks of knowledge and misconceptions about the astronomy subjects. .

In the previous studies about revealing students' misconceptions about basic astronomy concepts; multiple choice test [29], open ended questions [30], word association test (WAT) [31] and drawing method [32] were commonly used. Kurnaz [33] advocates that drawing method is the least preferred method for revealing students'misconceptions, especially in Turkey.

Science education includes many abstract concepts and students have to learn about them, which is difficult especially for earlier stages. Some of the abstract concepts in the science curriculum are as follows [34]:

1. Weight- Mass,

2. Matter-Object

3. Heat-Temperature,

4. Photosynthesis-Respiration,

5. Atom,

6. Velocity-Speed.

In addition to aforementioned concepts, it can be said that the concepts of basic astronomy subjects contain abstract concepts because students' ability to observe is limited, which is an effective reason for creating misconception.

1.6 Revealing Misconceptions

There are a vast variety of methods to determine students' misconceptions. In recent years, the impact of constructivist and inquiry-based learning approaches on educational environments and the deficiencies of traditional measurement-evaluation techniques in determining and measuring conceptual change have revealed alternative assessment-evaluation techniques and strategies. In addition, the techniques, which bring out the cognitive structure of the students, the connections between the concepts in this

structure and the relations between the concepts, have gained importance [35]. Of many methods open-ended questions [36], two-tier diagnostic test [37], prediction-observation-explanation (POE) [38], interviews about concepts [39], drawings [40], and word association test [35] can be given as the examples.

1.7 Objective of the Thesis

The aim of the study is to reveal middle school students' misconceptions about basic astronomy concepts thorough drawing method. When the literatur was examined, drawing method was chosen as the method because of the small number of studies done with the drawing method.

1.8 Research Problems

In this study, any hypothesis was presented since the study is based on a qualitative research method. Instead of the hypothesis, research problems were presented as follows;

1. What are the students' misconceptions about the size of the sun, the earth and the moon?

2. What are the students' misconceptions about how the solar eclipse happens?

3. What are the students' misconceptions about how the lunar eclipse happens?

2
Framework of the Study

2.1 Drawing Method

Drawing is a method, formed by the students transferring the concept or information related to a certain subject to a paper as it imagines in their minds. It could be used to determine students' misconceptions. This method provides little limitation to the student's response. Therefore, it is argued that the student can be use to reveal his/her own understanding and misunderstanding. However, there might be some difficulties in interpreting the drawings. Drawing is an important technique to reveal the students' knowledge, misconceptions and conceptual changes on a particular topic, without being limited to words [41]. Drawing is more efficient in revealing thought changes as it takes less time to describe, contains a lot of information and is assimilated easily [42]. In addition, through drawing, hidden knowledge and beliefs of the students are revealed without being dependent on the words and students who do not like to answer can respond questions easily and quickly whilst having an enjoyable time. Perception is a mental process as a meaning the impression of individuals. It is the process by which people subjective sense of sensations from the senses and the environment [43]. One of the ways of expressing mental perceptions is students' drawings. Drawings are a way of quickly touching the emotional world of participants and revealing their own experiences without being biased about a subject [44]. While children convey their observations and perceptions about the environment to us by drawing pictures, they interpret these pictures with their own thoughts and thus show how they perceive the outside world. As a result, children are in fact communicating their perceptions of information, events, objects and situations through images as a kind of communication [45]. The drawings are seen as effective because they can be completed in a short time and contain lots of information on a single sheet of paper. The drawings allow the teacher to discuss learning and to reflect on students' own learning. Drawings are considered as simple research instruments that enable easy comparisons at the international level [46]. While many children dislike answering questions, drawings can be completed quickly, easily and in an enjoyable way. Children's drawings provide a

'window' into their thoughts and feelings because they mainly reflect an image of his/her mind [47]. It is also a useful alternative form of expression for children who have difficulty expressing their thoughts verbally [48].

Conceptual understanding in the science course can be achieved through the concretization of abstract concepts by using visual materials and different instructional techniques [49]. In order to achieve conceptual learning in the most accurate way, the primary objective should be to identify the misconceptions students have. It is easier to teach new knowledge to the students than to retrieve the wrong information. Therefore, it is necessary to examine each concept very well beforehand and determine how this concept will be transferred to students.

In this study, the drawing method was used to learn the knowledge accumulations that the students had about the related subject as soon as possible without limiting with the words.

2.2 Relevant Studies

In this subtitle, some of the studies on the subject of astronomy in both national and international literature will be given as follows:

Yener et al. [50] aimed to reveal the cognitive structures and misconceptions of prospective science teachers about basic astronomy concepts in their study. In the scope of the study, they conducted research with 64 pre-service teachers from the department science education in a public university. The students were divided into two groups as experimental and control groups. The research was carried out by the case study which is a qualitative research method and the Word Association Test (WAT) was used as a data collection tool.

According to the results of the research, it was found out that in the experimental group where activity based courses were conducted; the association in concept networks was made more compared to the control group. When the relationship between teacher candidates and concept networks is examined, it is explained by the researcher that they have various misconceptions.

In this study, researchers [51] used phenomenological method, one of the qualitative research designs. The aim of the study is to investigate how the concepts of Earth, Sun

and Moon, which are the basic concepts of astronomy and which we can constantly observe, take place in the minds of 6th grade students and to reveal how students make these concepts mentally meaningful.

According to the results of the research, it was seen that the students' drawings at the end of the unit were more scientific than the drawings at the beginning of the unit. And it was seen that the drawings of the concepts of Sun, Earth and Moon in relation to some other astronomical concepts. In another study, the researcher aimed to examine and reveal the misconceptions of 8th grade students in secondary schools about the seasons [52]. According to the findings, it was found out that the students had the right ideas about the formation of the seasons as well as the wrong mental perceptions involving many misconceptions. Some of these false mental perceptions were as follows;

- 73.6% of the students thought that the weather gets warmer when the Earth gets closer to the Sun and the weather will cool down when it moves away from the Sun.
- 28.8% of the students thought that the main reason for the warm weather is due to the prolonged days.

Kalkan, in his study [53], investigated the misconceptions of primary and secondary preservice science teachers and prospective non-science teachers about basic astronomy subjects. According to results, researcher has found that the pre-service teachers had various misconceptions about basic astronomy. Comparing the participant responses in the pre-test and post-test in the astronomy test questions, he commented that some misconceptions could be changed easily and some would be very difficult to change.

The other study was done with 327 prospective science teachers a questionnaire, consisting of 9 open-ended questions, was used [54]. In the study, the researcher concluded that students mostly had similar misconceptions to those of previous studies. In addition new misconceptions also emerged in the study.

In another study, the researchers aimed at revealing the mental models of the students in the concept of Star, one of the main subjects of Astronomy [55]. The participants of the study consisted of 56 physics teacher candidates studying at Karadeniz Technical University during 2008-2009 academic year. 29 of these teacher candidates were

selected from 4th grade and 27 from 5th grade physics teacher. The researchers collected data with the Astronomy Concept Test (ACT), which was developed by them and consisting of 4 open-ended questions. The questions in the test are as follows;

1. How can the star concept be best defined? What comes to your mind when you hear this concept?
2. Why and how the stars shine?
3. Do stars change over time or in terms of their characteristics?
4. What kind of shape do you think the stars have? How do they get these shapes? Show it by drawing.

According to the results of the research, it was found that students' mental models about the concept of star do not overlap with scientific knowledge.

Kurnaz and Değirmenci conducted a study in 2010-2011 academic year at a primary and high school in Trabzon [56]. The aim of the study is to compare the perceptions of the students on the concepts of the planet, galaxy, satellite and the most frequently encountered concepts in daily life such as the earth, the sun, stars and the moon. The researchers collected their data by performing a screening model which is one of the descriptive research methods. Researchers in this study worked with a total of 206 students including,

- 37 7^{th} grade,
- 44 8^{th} grade,
- 50 9^{th} grade,
- 38 10^{th} grade and 37 11^{th} grade.

The researchers collected their data with the meaning meaning analysis table they had created with the help of an expert. Meaning analysis tables are two-dimensional tables that contain characteristics that will be analyzed in one dimension and features in another dimension, and they can be used effectively in teaching descriptive and distinctive features of concepts [57]. According to the results of the study, a table was prepared according to the student grade level for each concept and the results are shown in detail in these tables. According to the findings, it was found out that at each grade level students could not match the given concepts correctly and had various misconceptions about the concepts.

In another study, the researcher studied the concept of the Moon, one of the most studied and misconceptions of the literature [58]. In this study, alternative concepts about the phases of the Moon were determined and their elimination was studied. The aim of this study is to compare the traditional and cooperative methods for the determination of alternative concepts of 8th grade primary school students and to get a better understanding of this subject. Therefore, answers to the following questions were sought;

1. What are the alternative student concepts observed in the phases of the moon?
2. How do the 8th grade students' conceptual understanding levels change according to the teaching methods applied in the phases of the moon?

In this research, 33 students from 8^{th} grade of primary education were studied. The researchers selected the method of the study quasi-experimentally and divided the students into two groups: one control and one experimental group. Then, the students in both groups regularly performed The Moon Observation activities for one month in accordance with the instructions. This observation was checked twice a week on the board and the student observations were ensured by drawing on the board. Then, the traditional approach to the students in the control group and the students in the experimental group were formed by collaborative clusters. The data were collected after the last interviews. The researchers gathered data with an interview protocol to identify the pre-study information of both groups. This study has been found to be more successful in teaching the phases of the Moon according to the traditional education method. While there was no significant difference between the pre- and post-interview results of the traditional group, it was learned that the subject of the phases of the Moon was more effective in the group that the cooperative method was applied. According to the results of the research, both the control and the collaborative group were found to have more alternative concepts than the last interview. When the findings were examined, it was determined that the students in the cooperative group were more successful in the transition to scientific comprehension level, and it was determined that the cooperative education method in the collaborative group was effective in eliminating alternative concepts about the phases of the Moon.

The subject of seasons, one of the basic astronomy subjects, is one of the concepts in which students have difficulty in learning and have misunderstandings. In this study, it

was aimed to reveal the opinions and comprehension levels of the seasons in the 8th grade level of primary education [59]. The researchers conducted this study with 100 of 8th grade students from four different schools in Samsun and Ordu in 2010-2011 academic year. In this study, researchers collected data on open-ended questions and semi-structured interviews with students. According to the results of the study, the researchers stated that students did not internalize the subject of seasons sufficiently and they had various misconceptions about this subject.

Mental models are the intermediate stage between the conceptual models and the fact or phenomenon and have predictive and explanatory qualities to understand the truth [60]. For this reason, the researcher aimed to reveal and evaluate the mental models of some basic concepts of astronomy in this study and used descriptive approach for this reason [61]. The participants of the study were 76 7th grade students who were studying in a primary school in Trabzon in 2010-2011 academic year. The data were collected by asking 7 open-ended questions related to the students' theoretical knowledge about the sun, the earth and the moon. The questions that are prepared by taking into consideration the expert opinions are as follows;

1. What do you think about when you hear the concept of the Sun? Please explain.

2. What do you think about when you hear the concept of the earth? Please explain.

3. What do you think of when you hear the Moon concept? Please explain.

4. What shape do you think the Sun has? Show by drawing.

5. What kind of a shape do you think the Earth has? Show by drawing.

6. What kind of shape do you think the Moon has? Show by drawing.

7. Draw an image showing the Sun, Earth and Moon together. Show in your image how the Sun, Earth and Moon are moving according to you. Write down the names of the celestial bodies you draw. According to the findings obtained from the analysis of the data, few students showed scientific mental models for the earth and the moon, one student had a primitive model for the sun and the moon and the others had a synthesis model. In other words, students do not fully accept or understand the presented scientific models, but instead admit them by integrating them with primitive models.

In this study, the researcher aimed to determine the mental perceptions of 7th grade students on some basic astronomy concepts such as stars, constellations and comets [62]. In this study, the research data was collected from a total of 121 students from two different schools in Trabzon. The researcher collected the data by two different stages of success test. First of all, the students were asked about open-ended questions to reveal their knowledge of stars, constellations and comet concepts. These questions are as follows;

- What is a star? Write down what you know.
- What is the constellation? Write down what you know.
- What is a comet? Write what you know.

In the second stage, students were asked to draw for these three concepts. Participants were given a 30-minute period fort he second stage. According to the results of the study, it was found out that many students have quite insufficient knowledge and misconceptions about stars, constellations and comet concepts. For example, when the findings of comets are examined, it is understood that all of the respondents have alternative ideas. All of the students think of the comet as a star and the reason for this is thought to be due to the similarity of the writing of these two concepts.

In his study, the researcher aimed to develop a test of astronomy content from the 4th to the 8th grade on subjects of astronomy course intertwined [27]. The researcher began his study in 2011, completed 73 prospective science teacher, and ended in 2012. The study data were collected through the journals of the participants during the course of astronomy. Participants were asked to write some of their misconceptions before they came to the class and the questions to be developed for the test were prepared accordingly. As a result of the necessary analyzes, a total of 26 questions have been prepared and the number of these questions has been reduced to 18 according to expert opinion. Questions in the test were prepared as multiple-choice test. According to the results of the data analysis, it was seen that science teacher candidates had many misconceptions in astronomy subject area and stated that they were not sure about their answers even if they answered correctly.

The participants of the study consisted of a total of 22 students from 7^{th} grade. For the purpose of this study, the researchers are investigating the effect of the students'

misconceptions on the concepts of celestial bodies by using conceptual change texts. As part of the data collection tool, 12 concept cartoons were prepared and used within the scope of the unit, Getting to Know the Celestial Bodies. This concept caricatures test was applied to the study group as a pre-test before the teaching at the beginning of the related course and as a final test after the teaching. The data were analyzed by the dependent t-test. According to the findings of the study, it was found out that the students who formed the participants of the study had many alternative concepts about the unit of Getting to Know the Celestial Bodies and after the teaching process which includes the conceptual change texts, the majority of these alternative concepts were solved [63].

In another study, researchers aimed to reveal the effect of the misconceptions on the daily lives of their students in the field of solar system and space by using semi-structured interview technique with science teachers [64]. Data were collected with 5 volunteer science teachers. The participants were asked various questions and the answers given in the confirmation received from them were recorded. According to the results of the research analysis, the students' misconceptions are prevented from being misinterpreted and cause them not to be individuals with high awareness.

Coruhlu and Çepni [65] in their studies, aimed to identify the problems encountered by science teachers according to the content of the related course and to reveal the misconceptions they have. The study was carried out with 10 science teachers. In order to collect data, a semi-structured interview was conducted and the participants were asked “Do you encounter any difficulty or problem in teaching the Solar System and Beyond: Space Puzzle unit? If you are encountering, would you share these with us?” and the obtained data were recorded. In addition, observing the functioning of the related unit in the science course of 2 teachers, the problems they encountered in the classroom environment and the misconceptions they used while explaining the lesson were noted. According to the results of the research, it was learned that the teachers had misconceptions about the unit which includes these astronomy subjects and the motivations of the students were decreased. In addition, researchers concluded that the teacher's misinterpretation of concepts as a result of lack of knowledge or carelessness in the classroom may be effective in creating misconceptions in students.

In this study conducted by the researchers in 2015, they aimed to reveal the conceptual understanding of the students in the unit of celestial body using the quasi-experimental research design in order to compare the science teaching with the 5E method and the science teaching based on the Common İnformation structuring model. The study was carried out with 40 students in the experimental and control groups in the 2015-2016 academic year. The analysis of the study was carried out by using content analysis and nonparametric analysis techniques and as a result, it was concluded that the structure of common knowledge applied in the group was more effective on the conceptual understanding of seventh grade students according to the 5E teaching model applied in the student group [66].

In another study, the researcher studied with 78 grade 4 science teachers and he aimed to investigate the relationship between science teachers' attitudes to astronomy and their knowledge of basic astronomy concepts [67]. In order to collect data, students were administered a survey of the Attitudes toward Astronomy and 10 multiple choice multiple-choice astronomy tests at the beginning of the semester [27]. In the second part of the study, according to the answers to the questions in the test, the students were divided into three different attitude levels. A 30-minute interview was conducted with 9 randomly selected students. In the interview, the students were asked to explain the answers they gave to astronomy questions in more detail. According to the results of the study, it was stated that the groups of students who were divided into three categories did not take astronomy courses before, had misconceptions about basic astronomy concepts.

In a different study conducted by the researcher in 2015-2016 academic year. And the aim of this study is to reveal the mental perceptions of secondary school students for solar and lunar eclipses by drawing method [68]. The participants of the study were selected from a total of 131 students, from 5^{th}, 6^{th}, 7^{th} and 8^{th} grade, and asked two questions to collect their data. These questions are as follows,

1. Draw an image showing the solar eclipse. Write down the names of the celestial bodies you draw.
2. Draw an image showing the lunar eclipse. Write down the names of the celestial bodies you draw.

While the researcher was analyzing data, he/she obtained the result by using descriptive analysis method. The researcher divided the students' drawings in three categories as primitive, synthesized and scientifically. According to the results of the research, detailed frequency-percentage tables were formed according to the drawings made for solar and lunar eclipse. According to the findings, it was found that there were misconceptions and about solar and lunar eclipse at each class level. The mental misconceptions of the 5^{th} grade students were also found at the 6^{th}, $7^{th,}$ and 8th grades. According to the researcher, the fact that misconceptions continue with the level of the class and that they are more than the other classes in the 8th grade show that their misconceptions are quite resistant to change.

In another study, the researchers have studied 56 kindergarten children, 31 girls and 25 boys, in order to determine the about the shape of the earth and day and night concepts. While collecting the data, they chose a 10-question interview method which includes Earth 2 test and day and night formation concepts. They also used the mixed method when analyzing the data, and they concluded that all of the participants had synthetic alternative concepts related to the subject [69].

In their study, Bolat et al. aimed to determine the misconceptions of 5th grade students about the concepts of the sun, the earth and the moon by drawing method [70]. The study was conducted with 40 students and special case study method was used as a research method. Within the scope of the study, 6 open-ended questions were given to the students and they were asked to express their answers with drawing.

In the data analysis section, students' drawings and answers are analyzed separately, and the written answers are divided into 4 categories as complete comprehension, limited understanding, not understanding and cant responding. Researchers analyzed the drawings in 4 categories as completely correct, partially correct, wrong and no drawing. According to the results of the research, they stated that they had very important misconceptions as a result of the answers they gave to the written 6 questions and the drawings they made and they shared the sample student papers in their studies.

In this research, Trumper studied with 76 students, 49 of whom were female and 27 were male. İn this study, which was conducted with students in Physics Teaching Department, a quastionare with 19 questions was directed to the students and they

aimed to determine the misconceptions they had according to their answers. İn the analysis of the questions in the test directed to the students, the question-question was analyzed and analyzed the answers to all the questions and revealed the correct and incorrect answers of the students. According to the results of the study, university students had a very misconception in the scope of this 19-question test which included basic astronomy subjects [71].

When the studies in the literature were examined, it was observed that the participants in various groups from preschoolers to prospective teachers and even teachers, as seen above, had a lack of understanding of the astronomical issues of the sun, earth and the moon, and that the students had difficulty in understanding astronomy. There are studies in the literature above that the concepts of astronomy are generally structured based on the daily life of teachers and students. It is known that this situation often result in misconceptions [72]. As it seen in the studies conducted in the field of astronomy, it is noteworthy that most of the studies were conducted with prospective teachers. Since this study was conducted with 181 middle school students, it compensates this deficiency in the literature. In the studies examined, it was determined that the studıes were conducted in general astronomy course and studies examining the basic concepts of astronomy have been determined to be more limited.

As a result of the literature review, the failure of the answers given to the questions about astronomy shows parallelism with all grade levels. And students have similar misconceptions despite the grade levels. Based on this, it is concluded that there is no meaningful and permanent learning with basıc astronomy concepts.

Accordıng to Percy [73] existing problems and misconceptions in astronomy education cannot be solved by the commonly used teaching techniques. The Sun, Earth and Moon are subjects that have a broad scope and require knowledge in astronomy. Since these subjects also consist of abstract concepts, students have difficulty in maintaining these subjects in their minds.

In addition, related studies were mostly conducted in the form of questionnaires and tests. Therefore it is thought that, with this study drawing method will find an important place in the literature as an alternative test tool.

2.3 Theoretical Background

Learning is a lifelong process. There are many theories about learning and many factors that compose these theories. Ausubel meaningful learning theory is one of the learning theories. This study based on meaningful learning theory. According to Ausubel's learning theory; the most important factor affecting learning is the student's existing knowledge. And also it is widely accepted that a person's existing knowledge plays a critical role in learning science or any other lessons. When students and learners have a firm understanding of the concepts, how they are related to one another, and a few exemplars of each concept, they begin to develop their own framework that will help them draw conclusions about any situations throughout their learning process. Ausubel influenced the teaching of science with the meaningful learning theory he developed. According to the meaningful learning theory, the necessary prerequisite for effective learning is to gain pre-knowledge about the subject to be taught to the student. In addition, the concepts or information will be meaningful when they are associated with previously learned ones. If the student does not establish the necessary relationship for learning, he / she has difficulty in understanding the related subject. If the student does not understand this system and cannot see the relationship of the new topic, it has difficulty in understanding the subject. According to Ausubel, learning in the mind of the individual who is faced with various learning situations is the basis for later learning. These learning may not always be correctly constructed. It is also known that misunderstandings about any concept cause problems in understanding more advanced information on the subject and sometimes even prevent the learning of new information [74].

3
Method

This section includes the participants of the study, research design, limitations, ethical issues, assumptions and procedure about the research process.

3.1 Participants

The participants of this study consisted of 181 students from six different classrooms, including two classes on each graders 6^{th}, 7^{th} and 8^{th} respectively. The list of participants was given detail in Table 3.1. The age of the students was changed between 11 and 13 ages. The average number of students in classes was changed between 28 and 30. The study was based on volunteerism. In order to hide personal information about the participants, they were coded as S1 for the first student, S2 for the second student and so on.

Table 3.1 List of Participants

Grade	Male	Female	Total
6	S1, S2…S28 (n=28)	S29, S30…S64 (n=36)	64
7	S65, S66...S88 (n=24)	S89, S90...S131 (n=42)	66
8	S132, S133…S159 (n=28)	S160, S163...S181 (n=25)	53

3.2 Research Design

This study is based on a qualitative research methodology, in which students' basic astronomy concepts and understandings were revelaed. That's why, usually individuals' views, comments, or thoughts about concepts or an events were examined. In the current study, case study, which is a type of qualitative research method, was utilized. In case studies, it is easy for a researcher to investigate specific event, phenomena or status.

3.3 Procedure

In this study, it was aimed to reveal middle school students' misconceptions about basic astronomy concepts. The data collection stage took 40 + 40 minutes for each class and ended in two weeks. As it was the first weeks of semester, firstly, the students were introduced about the study and then the students were told about the research. For this purpose, it was aimed to reveal the readiness and misconceptions of the students. In order to reveal students' misconceptions about basic astronomy subjects, three questions were asked to them. Students were asked to answers to these questions by drawing. After the drawings were collected, each student was asked whether they were sure of the accuracy of the drawing. Their answers were asked to be either yes or no. These questions were as follows;

1. What are the sizes of the "moon", "earth" and "sun"? Please show them by drawing.

2. How does the solar eclipse occur? Please show it by drawing.

3. How does the lunar eclipse occur? Please show it by drawing.

In order to answer these questions, students were given three blank sheets of A4 size for each question. They were asked to do their drawings with the desired pencils or crayons. Students' name were kept confidential by coding as S1, S2, ….. ,S181. Analysis was done based on this coding scheme. With respect to the gathered data, semi-structured interviews were done with five students, who have misconceptions, for each question. Interviews were conducted with students who had misconceptions and had no difficulty in expressing themselves.

The semi-structured interviews were done with totally 15 students. The reason for using Interview method in this study is to investigate the main reasons of misconceptions that students held about the related subject in depth way. Students' misconceptions were standardized within certain encodings. More regular information was collected by coding the obtained data. When coding was done, it was easier to separate the data into categories and analyze the data. In the data analysis section, two different science teachers and researcher were studied together with the drawings of the students. One of the teachers is a science teacher who has 9 years of experience in a public school and the other is has worked in various educational institutions and has 3 years of experience.

Teachers built consensus while categorizing the students' drawings and proposed to classify the drawings according to 3 different categories and different grade levels. For this reason students' drawings were collected in three categories. These categories are;

No Drawings or I don't know: The students at this did not make a drawing or answered the question by saying "I do not know."

Drawings with misconceptions: The drawings in this phase were partially correct drawings with related scientific information and also involved some misconceptions.

Comprehensive Representations Drawings: The drawings in this phase were the most accurate and realistic drawings.

3.4 Assumptions

Students'answers to the questions was assumed to be sincere and reliable. During the research process, the researcher was assumed to be impartial and it was assumed that the researcher did not direct the students to affect the study's results.

3.5 Limitations

Limitations of the study as it follows;

The data collection stage was limited to 181 students.

The data collection tool was also limited to the drawing method and semi structured interview.

3.6 Ethical Issues

In this study, to cover ethical issue following precautions were taken into account;

Participant students and the school administration were informed about the purpose, content and implementation stages of the study.

Within the scope of the study, the Ministry of National Education was informed and necessary requirements were taken (please see the Appendix) .

4
Results and Discussion

4.1 Results

In this study, middle school students' misconceptions about the concepts of astronomy were investigated. The results of the students' answers to the three questions are given in this section.

The first question is the question of comparing the sizes of the sun, earth and the moon. The correct sort for the answer that includes drawings which "the sun is larger than the earth" and also " the earth is larger than the moon". Drawings with comparasions of the celestial bodies other than the correct response were considered as misconceptions.

The second and third questions are related to the eclipses. The correct answers to these questions are the drawings that includes the sizes and the order of the correct celestial bodies. Drawings that do not contain one or more of this criteria are considered as misconceptions. Categorization of students' drawings was given in Table 4.2.

Table 4.2 Categorization of Students' Drawings

	1st Question			**2nd Question**			**3rd Question**		
	6th Grade	**7th Grade**	**8th Grade**	**6th Grade**	**7th Grade**	**8th Grade**	**6th Grade**	**7th Grade**	**8th Grade**
	f %	**f %**	**f %**	**f %**	**f %**	**f %**	**f %**	**f %**	**f %**
No Drawings or I don't know	14 (%21)	8 (%13)	5 (%9)	16 (%25)	4 (%6)	7 (%13)	11 (%17)	5 (%7)	6 (%11)
Drawings with Misconceptions	24 (%37)	16 (%24)	7 (%14)	30 (%46)	12 (%18)	7 (%13)	27 (%42)	11 (%16)	12 (%23)
Comprehensive Representations Drawings	26 (%40)	42 (%63)	39 (%76)	18 (%28)	50 (%81)	37 (%72)	26 (%40)	50 (%75)	33 (%64)

Total of the 181 students; 74 (41%) students for the first question, 76 (42%), students for the second question, and 72 (40%) students for the third question had a lack of knowledge and misconceptions about the related subject.

For the first question, 27 of the students (15%) stated that they don't know the size of the sun, earth and moon and did not make drawing. 47 of them (26%) made a drawing containing misconceptions about the question. In total, 41% of the students' drawings

contained scientifically inaccurate expressions. 107 (59%) of the students answered the first question by making scientific drawings.

Common misconceptions related to the first questions were as follows:

- The moon is larger than the earth,

- The earth is larger than the sun,

- The moon is larger than the sun.

According to this study, it was seen that middle school students have difficulty in comparing the size of the sun, earth and moon.

For the second question, 27 of the students (15%) did not make the drawing by saying that they did not know the question. 49 of them (27.0%) made drawings containing misconceptions. 105 students drawings (58.0%) were scientifically correct. Although the data obtained from the majority of the students are more scientific, it is noteworthy that 76 students (42%) have incomplete and incorrect information about the subject.

For the third question, 22 of the students (12%) did not make any drawings.. 50 of the students' (28%) drawings involved misconceptions. 109 of the students (60%) answered the third question by making scientific drawings.

Common misconception revealed from the students' drawings are given on Table 4.3.

Table 4.3 List of Misconceptions

Number	Misconceptions	f
1	The Earth is bigger than the sun *(S11, S17, S22, S28, S33, S51, S93, S100, S105, S134, S169, S171)*	12
2	The moon is bigger than the Earth *(S4, S6, S8, S9, S13, S15, S16, S27, S32, S42, S45, S46, S51, S52, S58, S59, S67, S71, S72, S77, S82, S90, S105, S137, S143, S172)*	26
3	The moon is bigger than the sun *(S7, S27, S69, S72, S87, S98, S101, S129, S177)*	9
4	In the solar eclipse, the Earth gets into the middle of the sun and the moon *(S1, S4, S5, S8, S11, S15, S16, S17, S21, S22, S32, S33, S45, S46, S72, S93, S94, S102, S118, S124, S136, S141, S150, S163)*	24
5	In the solar eclipse, the Earth gets in front of the sun and the moon has no function *(S27, S48, S49, S50, S51, S59, S61, S62, S69, S87, S122, S177)*	12
6	In the solar eclipse, the moon is in the phase of the full moon *(S20, S39, S110, S127, S143, S169)*	6
7	In the solar eclipse, the moon gets in front of the sun *(S3, S30, S41)*	3
8	In the lunar eclipse, the moon is in the phase of the new moon *(S39, S42, S127, S143, S169)*	5
9	In the lunar eclipse, the sun doesn't emit light *(S13, S15, S27, S29, S41, S47, S50, S52, S81, S100, S140, S148, S167)*	13
10	In the lunar eclipse, the moon gets in front of the sun *(S6, S11, S28, S57, S87)*	5
11	In the lunar eclipse, the moons gets between the sun and the Earth *(S1, S4, S10, S12, S17, S20, S21, S46, S48, S51, S62, S66, S73, S76, S104, S124, S137, S139, S141, S163, S180)*	21

In order to reach more detail knowledge about students' drawings especially for the ones which involves misconceptions, semi-structured interviews were done with the students. One of the purposes of the interviews is to understand why students made a drawing with misconception. 15 students, whose drawings included misconceptions, were chosen to interview.

- The interview about the first research question done with the students coded as S124, S67, S27, S22 and S9. Furthermore, S124, S67 and S27 these students' drawings are presented.

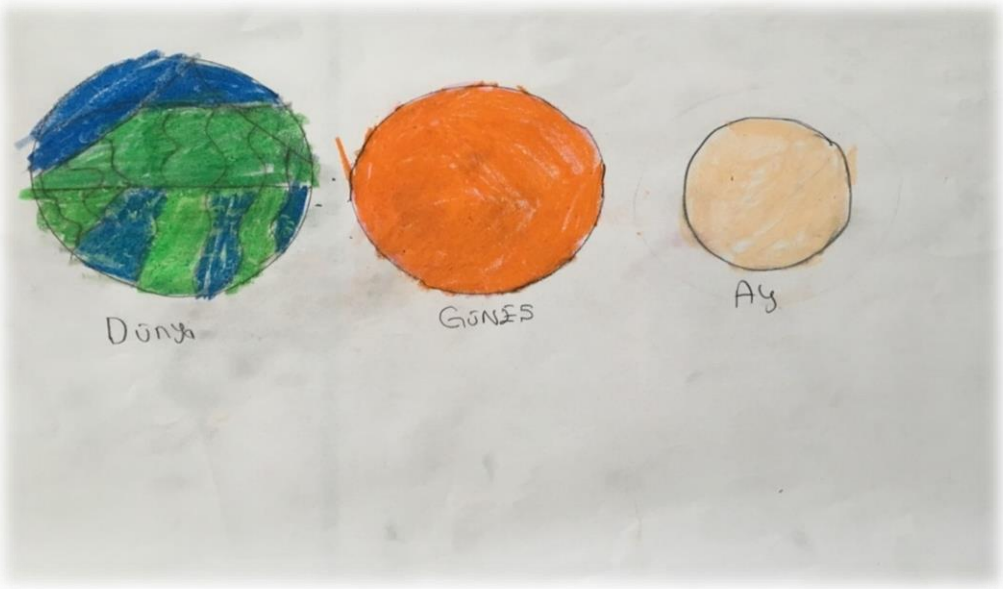

Figure 4.2 Figure of S124

Researcher: Could you please explain what did you try to explain by this drawing?

S124: These are sun, moon and the Earth. All of them are round like a ball or similar to a circle.

Resarcher: The Earth has the largest area. Why did you think that the Earth is the larger than the others (namely, sun and moon)?

S124: The Earth is so big. There are thousand of mountains, oceans, and seas in it. In addition, billions of people live in there. Moon is the satellite of the Earth, so it's the smallest one.

Researcher: Why is the sun is smaller than the Earth?

S124: Becuase it is a star and starts are smaller calestial bodies.

Researcher: Why do you think like this?

S124: Stars are always small. Sun is also a star, so it is small.

Figure 4.3 Figure of S67

Researcher: Could you please explain what did you try to explain by this drawing?

S67: There are sun, moon and the Eart in the Picture. Because of the fact that ¾ of the Eart is consist of water, I colored it in blue.

Researcher: As I understand from the Picture, the sun is largest one, and then the moon and the smallest is the Earth. Why did you draw like this?

S67: The sun is the largest calestial body. It's source of light for the Earth and the moon. The Earth is also bigger calestial body but the sun can cover the Earth.

Researcher: How about the moon?

S67: The moon is middle one. It's also big but smaller than the sun.

Researcher: In the picture, the moon seems larger than the Earth.

S67: The moon seems smaller at nighst but indeed, it’s so big.

Researcher: Why do you think like this?

S67: Becuase astronauts spent so much time to discover the moon’s surface. It likes a larger piece of land. There are so many places on the moon and waiting to be discovered.

Figure 4.4 Figure of S27

Researcher: Could you please explain what did you try to explain by this drawing?

S27: There are sun, moon and the Earth in the Picture.

Researcher: Why did you draw the moon larger than the sun and the Earth?

S27: Because it’s the biggest one. It sometimes getting smaller but normally, it is huge.

Researcher: The sun and the Earth have round shape in the picture. Why?

S27: They are also round celestial bodies.

Researcher: Could you please explain why the moon is the largest on among the others (sun and the Earth)?

S27: The moon is satellite of the Eartch. It turns around the Earth. If it was smaller, then it couldn't turn around it.

Researcher: Is the moon larger than the sun?

S27: Yes, I think.

Researcher: Why do you think like this?

S27: Hmmm. The moon reflects the sun's light at nights, so the environment becomes luminous. If it was smaller than the sun, this couldn't happen.

Figure 4.5 Figure of S22

Researcher: Could you please explain what did you try to explain by this drawing?

S22: I drew the sun, the moon and the Earth. Then I colored them. The sun is a yellow colored star. It spreads light and heat. The moon is the satellite of the Earth. And the Earth is where we live in.

Researcher: The Earth is largest on among the others. Why?

S22: The Earth is the largest on, so I did it...

Researcher: Why do you think like this?

S22: As I remember, the Earth is larger than both the sun and the moon. It is also the biggest planet.

Researcher: How do you know?

S22: I read it in a scientific journal as I remember.

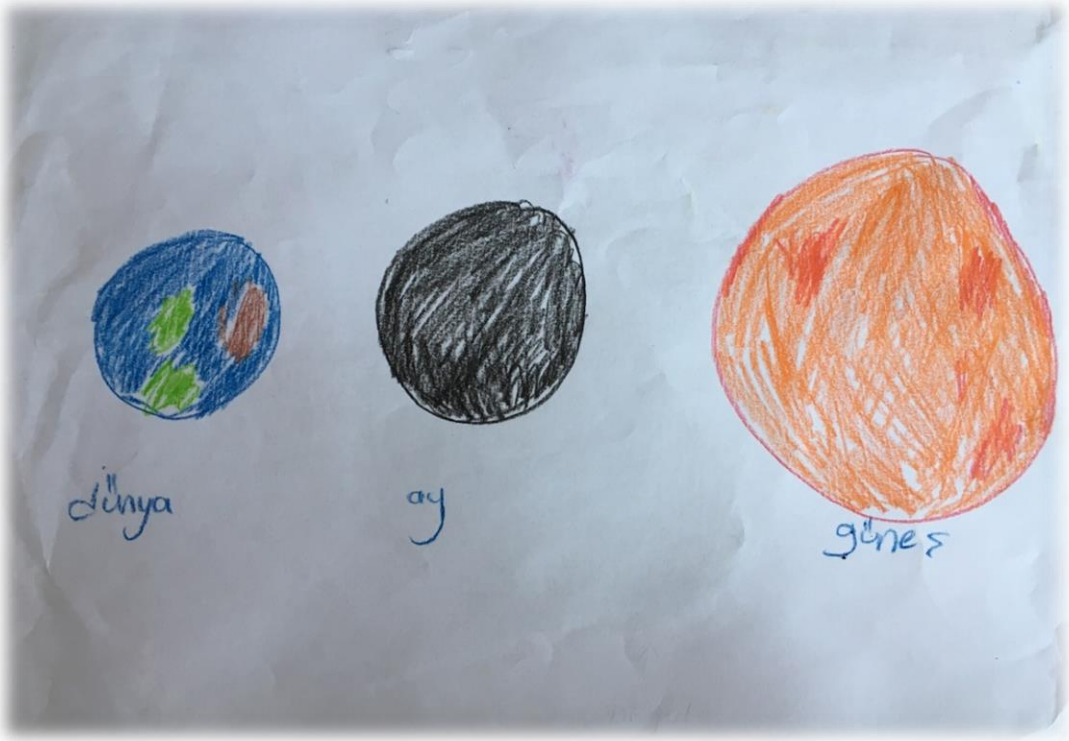

Figure 4.6 Figure of S9

Researcher: Could you please explain what did you try to explain by this drawing?

S9: The moon, the sun and the Earth.

Researcher: Could you please give more information about your Picture. For example, which one is the largest cellestial body?

S9: The sun is the largest one. We see it smaller but indeed, it is really big.

Researcher: Why?

S9: It’s too far away from the Earth.

Researcher: How about the others (the moon and the Earth)?

S9: The moon is the second larger one and the Earth is the smallest.

Researcher: Why do you think like this?

S9: The moon is so big because it lighten up everywhere at nights. If it was not bigger than the Earth, it couldn’t do it.

- The interview about the second research question done with the students coded as S72, S30, S11, S39 and S122. Furthermore, students coded as S72, S30 and S39 their drawings and interviews are presented.

Figure 4.7 Figure of S72

Researcher: Could you please explain what did you try to explain by this drawing?

S72: I drew the solar eclipse.

Researcher: How does the solar eclipse occur?

S72: The Earth is in the middle of the sun and the moon.

Researcher: What does this mean?

S72: The Earth is turning around of the sun, so it sometimes comes into the middle for the moon and the sun. That's why, the light from the sun doesn't reach to the Earth and everywhere becomes darker.

Researcher: Does the solar eclipse ocur everytime?

S72: No. When all of them (the sun, the moon and the Earth) becomes on the same line, it occurs. In addition, when the full moon is on the sky, it is possible to ocur.

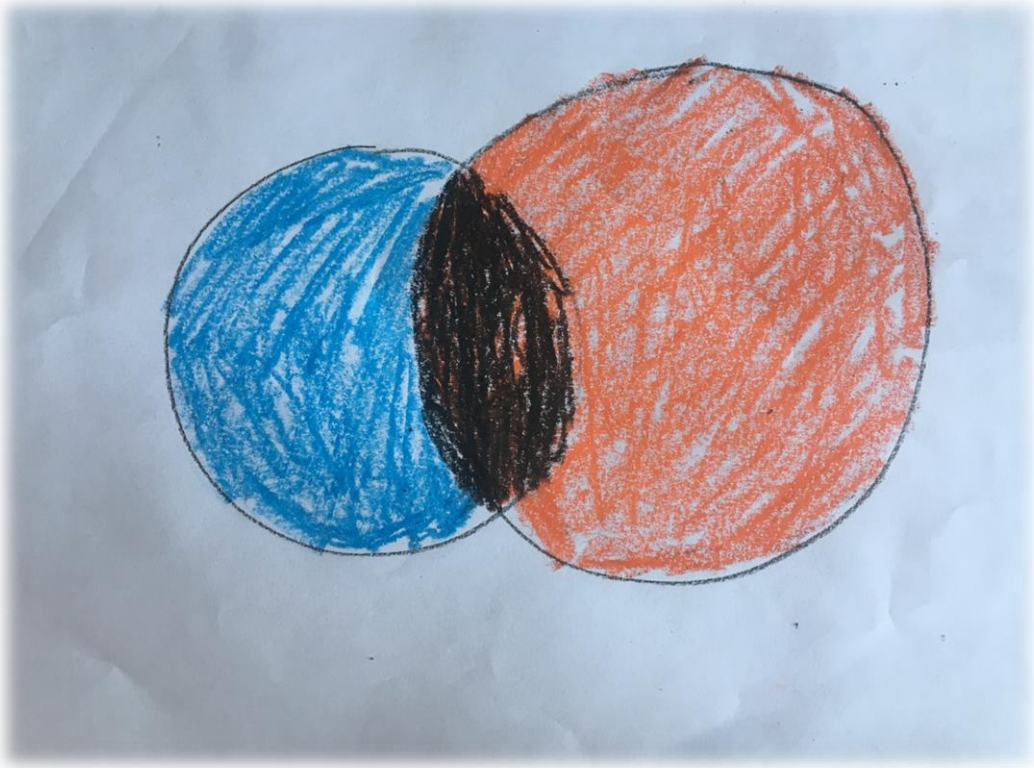

Figure 4.8 Figure of S30

Researcher: Could you please explain what did you try to explain by this drawing?

S30: The Earth comes in front of the sun, so the lights doesn’t reach from the sun to the Earth. Then, the solar eclipse occurs.

Researcher: Could you please explain a little bit more detail?

S30: Some parts on the Earth gets darker.

Researcher: Does the solar eclipse ocur everytime?

S30: Yes but we can’t see every solar eclipse.

Researcher: Why?

S30: Because the Earth is turning around of the sun, so it sometimes occurs in some other parts of the Earth, and sometime occurs where we live. In other words, it is not possible to see evey solar eclipse.

Researcher: Do you think that the moon has a role in a sloar eclipse?

S30: No. There is no function of it for a solar eclipse. The moon has a role for the lunar eclipse.

Researcher: Then, where is the moon when the solar eclipse is occuring?

S30: The moon turns around the Earth, so it continues to turn around it.

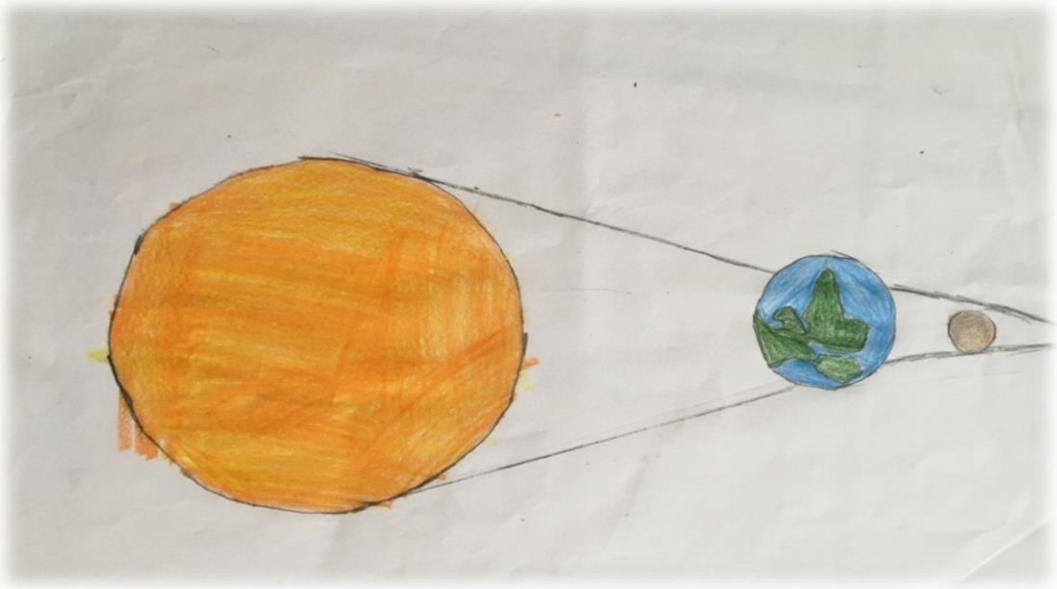

Figure 4.9 Figure of S11

Researcher: Could you please explain what did you try to explain by this drawing?

S11: I drew the solar eclipse. The Earth comes into the middle of the sun and the moon, when it's turning around of the sun. That's why, the sunlights can'T reach to the Earth.

Researcher: Why can't the sunlight reach to the Earth?

S11: I don't know. Sometimes the Earth getting away from the sun, so the sunlights can't reach the Earth.

Researcher: What is the role of the moon for the solar eclipse?

S11: For the solar eclipse, there must be the sun, the moon and the Earth. All of them must be on the same line.

Researcher: Why do they have to be on the same line?

S11: I don't know.

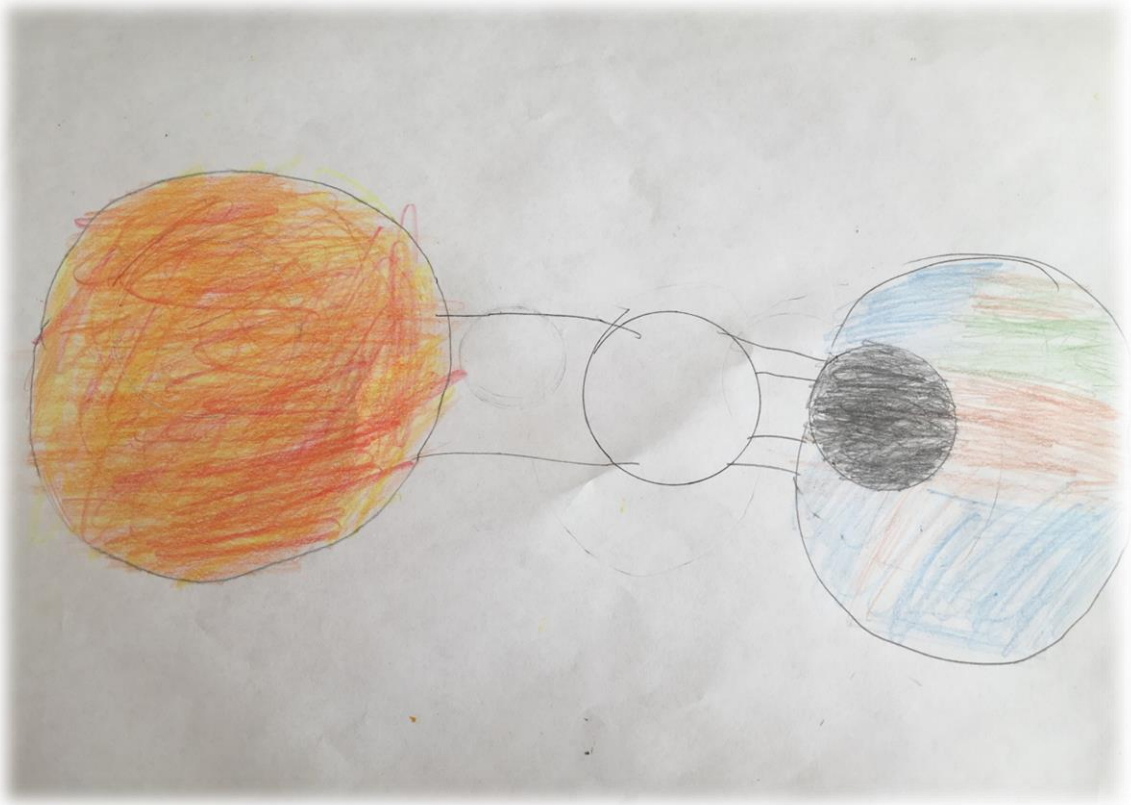

Figure 4.10 Figure of S39

Researcher: Could you please explain what did you try to explain by this drawing?

S39: I tried to draw the solar eclipse. When the solar eclipse occurs, some parts of the Earth gets darker.

Researcher: Why do the some parts of the Earth get darker?

S39: The moon hinders the sunlight to reach to the Earth. Then it becomes darker

Researcher: How does the moon hinder the sunlight?

S39: When the moon becomes the full moon, it gets the largest position. When it's turning around of the Earth, it sometimes comes in front of the sun. Then, it hinders the sunlight.

Researcher: Are you sure?

S39: Yes, of course. When the solar eclipse occurs, some parts of the Earth gets darker, some other don't.

Researcher: Why do you think like this?

S39: I don't remember but probably, I learnt in the previous years.

Figure 4.11 Figure of S122

Researcher: Could you please explain what did you try to explain by this drawing?

S122: I drew the solar eclipse. It is a very important event. It doesn't ocur everytime. When it ocuurs, the environment gets darker.

Researcher: Why does the environment get darker?

S122: The sunlight can't reach to the Earth?

Researcher: Why can't they reach?

S122: I don't know.

- The interview about the third research question done with the students coded as S6, S87, S28, S46 and S127 are given below. Furthermore, students coded as S87, S28, S6, S46 and their drawings and interviews are presented.

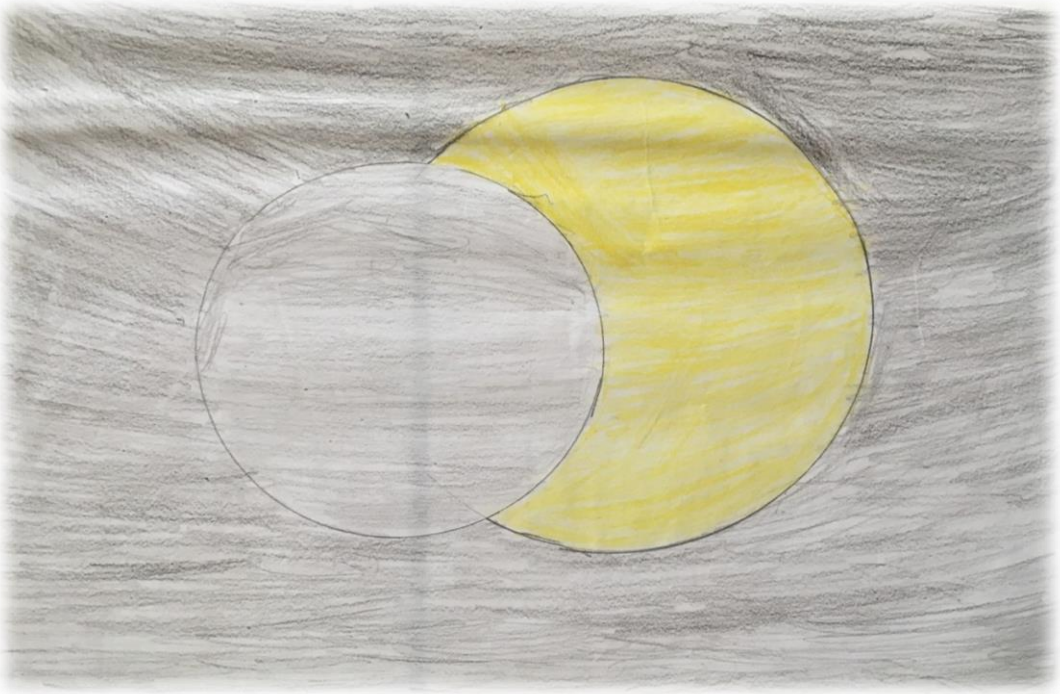

Figure 4.12 Figure of S6

Researcher: Could you please explain what did you try to explain by this drawing?

S6: When the lunar eclipse occurs, the moon comes in front of the sun. That's why, the sunlight can't reach to the Earth, so everywhere gets darker.

Researcher: Can't the sunlight reach to the Earth? Right?

S6: Yes, right.

Researcher: Then, where does the sunlight go if they can’t reach to the Earth?

S6: They go to the moon.

Researcher: After that, what happens?

S6: The Earth gets darker.

Researcher: Why does the moon come in front of the sun?

S6: When the moon is turning around of the Earth, it sometimes comes in front of the sun.

Researcher: What is the phase of the moon in your picture?

S6: It is the full moon. The lunar elipse just occurs when the moon is the full.

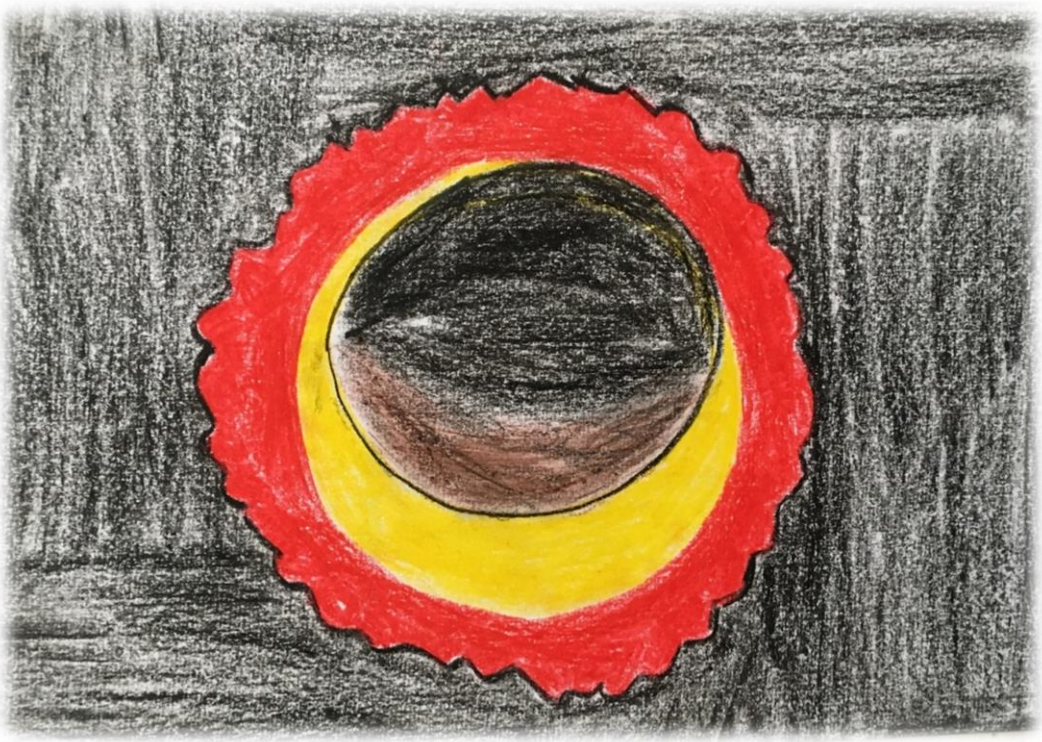

Figure 4.13 Figure of S87

Researcher: Could you please explain what did you try to explain by this drawing?

S87: The lunar eclipse. When the moon comes in front of the sun, the lunar eclipse occurs.

Researcher: How does it occur?

S87: When the moon is turning around of the Earth, it sometimes comes in front of the sun. Then, some parts of the sunlight reaches to the moon, instead of the Earth. That's why, the Earth gets darker.

Researcher: When does it ocur? Everytime?

S87: No, not everytime. When the moon is in the phase of the new moon, it occurs. In the new moon phase, the moon gets bigger and have a round shape, so it receives much more sunlight from the sun, when it is in the phase of the new moon.

Researcher: Then, doesn't the Earth become bright?

S87: No because the moon doesn't reflect the sunlight.

Researcher: Why doesn't it reflect?

S87: I don't know. Maybe the reflected lights can't reach to the Earth.

Figure 4.14 Figure of S28

Researcher: Could you please explain what did you try to explain by this drawing?

S28: The lunar eclipse. There are the sun and the moon.

Researcher: How does the lunar eclipse occur?

S28: When the moon comes in front of the sun, some sunlight reach to the moon, instead of the Earth.

Researcher: Doesn't the Earth become bright, when the moon has much more light?
S28: Half of the moon gets darker and the other half gets bright. When the dark side of the moon is observed, then it is time for the lunar eclipse. In addition, the moon must be in the phase of the new moon for the lunar eclipse.

Researcher: When we look at the moon from the Earth, which side of the moon can be seen? Darker or brighter side?

S28: The people in some parts of the Earth observe the brighter side of the moon, while the others see the darker side. The people in the darker side also observe the lunar eclipse.

Researcher: Does the lunar eclipse ocur everytime?

S28: No. It just happens when the moon is in the phase of the new moon.

Researcher: Any other time?

S28: No. Just in the new moon phase.

Figure 4.15 Figure of S46

Researcher: Could you please explain what did you try to explain by this drawing?

S46: In the lunar eclipse, the moon comes between the sun and the Earth. It prevents sunlight to reach to the Earth. That's why, the Earth gets darker.

Researcher: When does the lunar eclipse ocur?

S46: When the moon, the sun and the Earth gets on the sam eline.

Researcher: Is there any othre requirement fort he lunar eclipse?

S46: In addition, the moon must be in the phase of the full moon.

Researcher: Why full moon?

S46: In the full moon phase, the moon becomes the largest position and prvents most of the sunlight.

Figure 4.16 Figure of S127

Researcher: Could you please explain what did you try to explain by this drawing?

S127: The lunar eclipse. The moon gets darker in the lunar eclipse.

Researcher: How does the moon get darker?

S127: When the moon is not received sunlight, it gets darker.

Researcher: When is the moon received sunlight?

S127: At nights, sunlight can’t reach to the moon. The moon gets away from the sun. Similarly, the Earth gets darker.

Researcher: How?

S127: When the moon turns around of the Earth, it goes away from the sun. Then the lunar eclipse occurs.

According to these results, although many students drew scientifically corrected drawings about the questions, it was reached that almost half of them have misconceptions about the sun, the Earth and the moon. In the interviews, conducted with students, it was also determined that there are similar misconceptions like their

drawings. That's why; the results obtained indicate that drawing method is effective in determining the students' misconceptions. These results indicate that middle school students have lack of knowledge about the sun, the moon, and the Earth. Also, the findings show that students' drawings contain less misconceptions when their cognitive development transfer from concrete to abstract with respect to Piaget's theory.

4.2 Discussion and Conclusion

Based on the results of the study, it was reached that the middle school students have a large number of common misconceptions about basic astronomy subjects.

For the first question; some of the students think that the Earth is larger than the sun. When the reason why students think like this was investigated, it was found that students could not revive the concepts about proximity and distance in their minds, and interpret according to their appearance from the Earth. The distance between the sun and the Earth is approximately 150 million kilometers. However, students ignore this distance because they could not concretize it in their minds. Their thoughts emerge based on their observations but it is difficult for them to concretize such concepts, so they have so many misconceptions.

Previous studies from the literature show that students from different grade levels have same misconception frequently. For example, the misconception "the Earth is greater than the sun" was also found in the studies done by Baloğlu Uğurlu [75], Bolat et al. [76] and Göncü and Korur [10].

Likewise, students, based on their observations, think that the moon is larger than the sun. Yet, they didn't take consider the fact that the moon is closer to the Earth than the sun, so it seem larger.

According to the results of the interviews for the first question, it was also found that the middle school students also have misconceptions such as the shapes of the Earth, the sun and the moon are round, the Earth is the largest planet, stars seem smaller, so the sun also seems smaller.

The second and third questions were related to the solar eclipse and the lunar eclipse. The goals of these questions were enabling the students to reflect the schemes of the eclipses in their minds by drawings. Within the scope of the questions, various

misconceptions were obtained. From the results found in this study, it is clear that students also do not understand processes of eclıpses. Middle school students' representation drawings in this study indicated that there were lots of misconceptions.

For the second question, it was concluded that the majority of the students confuse the solar eclipse with the lunar eclipse. This shows that the students have lack of knowledge about the topic.

It was reached that students have lack of knowledge about the celestial bodies. The common misconception was found as "In the solar eclipse, the moon gets in front of the sun." The other misconceptions were "In the solar eclipse, the Earth gets in front of the sun and the moon has no function" and "In the solar eclipse, the Earth gets into the middle of the sun and the moon." It was also observed that some of the students had the misconception that "The moon is in the full moon phase during the eclipse."

For the third question, it was concluded that the students have similar misconceptions with ones for the solar eclipse. There were many drawings in which students confused the lunar eclipse with the solar eclipse. Based on the student drawings and expressions, the common misconception was found as "In the lunar eclipse, the moon gets in front of the sun." The other misconceptions were found as "In the lunar eclipse, the sun doesn't emit light", "In the lunar eclipse, the moons gets between the sun and the Earth", and "In the lunar eclipse, the moon is in the phase of the new moon."

In addition to these misconceptions, it was also observed that while students accurately depicted the positions of celestial bodies involved in the eclipses, they expressed them without considering their sizes.

In the related literature, Küçüközer et al. [77] found that elementary school students have lack of knowledge the positions of the moon, the sun and the earth during the eclipses. In the other study done by Taşcan and Ünal [78], they reached that students have misconceptions about the solar and lunar eclipses. Trumper [23] also found that students have common misconceptions related to the position of celestial bodies during the lunar eclipse. In the other study done by Trumper [71], it was reached that university students did not know the phase of the moon during the solar eclipse. Similarly, according to the results of the study conducted by Kalkan [53], students have misconceptions about the solar and moon eclipses.

When the students' misconceptions about the sun and lunar eclipse were examined, it was observed that they had common and various misconceptions. They couldn't visualize the eclipses in their minds. They have lack of knowledge about the darkness on the Earth during the solar eclipse. In addition, it was observed that the students did not know the positions of the celestial bodies during the eclipses.

The main reason why students have misconceptions about the lunar eclipse and solar eclipse is that they have limited ability to cconcretize these natural phenomena in their minds. As a result of the examinations based on the findings, it was concluded that misconceptions occurred due to lack of knowledge in students.The results from interviews with S11, S122 and S87 also support this conclusion.Students with a lack of knowledge answer the questions by using their knowledge about the concept.

The main reason why students have misconceptions about the lunar eclipse and solar eclipse is that they have limited ability to cconcretize these natural phenomena in their minds.

In addition, textbooks or various journals can be deduced from the findings of the study as one of the important reasons for misconceptions. The result of the interview with S22 supports this situation. This result, which is determined about the reasons of misconceptions, is also mentioned in some studies in this field in national and international literature [79], [80].

According to the results of the interview with S39, the students' old knowledge causes different misconceptions.
In addition, this can be inferred from the findings of previous experiences and thoughts as a reason for students' misconceptions.

Also, making wrong associaitons is another reason for misconceptions. This one is expressed differently in the literature sources about the causes of misconceptions as over-generalization based on analogies [79].
Interviews with S46, S6, S127 in this study also support this conclusıon. Incorrect expressions in textbooks and media can be another source for the misconcepitons. In this context, teachers should use instructional materials which enable students to concretize the phenomena. The courses about the astronomy should be prompted with various videos and visuals.

4.3 Implementation For Future Research

Since the concepts in the subject of astronomy are related with the daıly life, teachers should motivate the students by specifying the relationship astronomy with daıly life before starting the teaching of this subject. Incomplete information and misconceptions given to students in the teaching and learning process affect the student in the following years. For this reason, it is suggested that the subject to be transferred within the scope of the subject, teachers should be done with an appropriate and meaningful teaching method according to the level of the student.

For the further studies, it can be recommended that longitudinal studies should be done about the topic of astronomy. Similar studies can be done with students from different grades. More questions can be asked to have deeper information about students' miscocneptions.

In addition to the quantitative method used in studies where students have misconceptions about astronomy at different grade levels, qualitative methods such as interview and observation should be conducted. Also drawing method activities in conjunction with individual or focus group interviews have been successfully used to explore students' ideas about abstract concepts. Drawings are often an under-utilized research tool in primary classrooms. Drawings can provide valuable information for teaching and learning process and determining misconceptions and, more importantly, they provide an open-ended means for creative expression that is difficult to achieve with other assessment strategies.

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Contact Information: eekoca@gmail.com

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MEB Permission Paper

T.C.
ŞEHİTKAMİL KAYMAKAMLIĞI
İlçe Milli Eğitim Müdürlüğü

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Hüseyin DALKIRAN
Şube Müdürü

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İlçe Milli Eğitim Müdürü

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Kemal YAVUZCAN
MÜDÜR

T.C. AYSEL TEKİNALP İLKOKULU MİLLİ EĞİTİM ŞEHİTKAMİL

Adres : Yaprak Mah.Sinler Sk.No:18/A 27400 ŞEHİTKAMİL/GAZİANTEP
Ayrıntılı bilgi için irtibat : Şb.Md. Hüseyin DALKIRAN - Temel Eğitim - Şefi İsmail ŞAHAN - VHKİ Cuma SARIKAYA
Telefon : 0342 3232440 –Dahili : 161- Faks:0342 3261193- Email : sehitkamil27@meb.gov.tr
İnternet : http://sehitkamil.meb.gov.tr