

MIDDLE SCHOOL STUDENTS' MISCONCEPTIONS ABOUT ASTRONOMY  
CONCEPTS AND THEIR ATTITUDES TOWARDS ASTRONOMY

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## ABSTRACT

### MIDDLE SCHOOL STUDENTS' MISCONCEPTIONS ABOUT ASTRONOMY CONCEPTS AND THEIR ATTITUDES TOWARDS ASTRONOMY

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In this study, 6th and 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy were investigated. Moreover, the relationships between students' misconceptions about astronomy concepts and their attitudes towards astronomy and differences in gender, grade level, interest in astronomy, and future occupation in terms of misconceptions about astronomy concepts and attitudes towards astronomy were investigated. The sample consisted of 360 6th grade and 348 7th grade students. A demographic questionnaire, the Misconceptions Test About Astronomy Concepts (MTAC), and the Attitude Astronomy Scale (AAS) were used to collect data. The students' misconceptions about astronomy concepts were assessed using Microsoft Excel. MANOVA and correlational analysis were also conducted to analyse the data. The analysis revealed that both 6th and 7th grade students had the same misconceptions. The correlational analysis revealed that for 6th grade and 7th grade students, there were positive correlations between their attitudes towards astronomy and misconceptions about astronomy concepts. In terms of attitudes towards astronomy, there was no significant difference between 6th and 7th grade students for all sub-factors. MANOVA analysis revealed that being interested was a considerable difference between male and female students. There was a significant impact of interest in astronomy and future occupation on

all sub-factors of AAS. For 6th and 7th grade students, MANOVA analysis revealed a significant gender difference only for the 6th grade students' misconceptions score. For both 6th and 7th grade students, there was a significant difference in their interest in astronomy in terms of correct response scores, but for misconception scores, the significant difference was observed for only 7th grade students. For future occupation, the significant difference was only found in 7th grade students' correct response scores.

Keywords: Misconceptions About Astronomy Concepts, Attitude Towards Astronomy, Gender, Interest in Astronomy, Future Occupation

## ÖZ

### ORTAOKUL ÖĞRENCİLERİNİN ASTRONOMİ KAVRAMLARINA İLİŞKİN KAVRAM YANILGILARI VE ASTRONOMİYE KARŞI TUTUMLARI

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Bu çalışmada, ortaokul 6. ve 7. sınıf öğrencilerinin astronomi kavramlarına ilişkin kavram yanılgıları ve astronomiye yönelik tutumları incelenmiştir. Ayrıca, öğrencilerin astronomi kavramlarına ilişkin kavram yanılgıları ile astronomiye yönelik tutumları arasındaki ilişkiler ile astronomi kavramlarına ilişkin kavram yanılgıları açısından cinsiyet, sınıf düzeyi, astronomiye karşı ilgi ve gelecekteki meslek farklılıkları ve astronomiye yönelik tutumları arasındaki ilişkiler incelenmiştir. Araştırmaya 360 kişi 6. sınıf ve 348 kişi 7. sınıf öğrencisi olarak katılmıştır. Veri toplamak için demografik bilgiler anketi, Astronomi Kavramları ile ilgili Kavram Yanılgısı Testi (MTAC) ve Tutum Astronomi Ölçeği (AAS) kullanılmıştır. Öğrencilerin astronomi kavramlarına ilişkin kavram yanılgıları Microsoft Excel kullanılarak değerlendirilmiştir. Verileri analiz etmek için MANOVA ve korelasyon analizi kullanılmıştır. Yapılan analize göre, 6. ve 7. sınıf öğrencileri aynı kavram yanılgılarına sahiptir. Ayrıca, 6. sınıf ve 7. sınıf öğrencilerinin astronomiye yönelik tutumları ile astronomi kavramlarına ilişkin kavram yanılgıları arasında pozitif korelasyonlar vardır. Astronomiye yönelik tutumlar açısından ise tüm alt faktörler için 6. ve 7. sınıf öğrencileri arasında anlamlı bir farklılık bulunmamıştır. Kız ve erkek öğrenciler arasında astronomiye karşı ilgili olma açısından anlamlı bir fark vardır. Astronomiye olan ilginin ve gelecekteki mesleklerin AAS'nin tüm alt faktörlerinde önemli bir etkisi vardır. Bunun yanında, yalnızca 6. sınıf öğrencilerinin kavram yanılgıları puanları ve cinsiyet açısından anlamlı bir fark vardır. 6. ve 7. sınıf öğrencilerinin astronomiye ilgilerinde doğru

yanıt puanları açısından anlamlı bir farklılık bulunurken, kavram yanılgısı puanları açısından sadece 7. sınıf öğrencileri için anlamlı farklılık gözlenmiştir. Gelecekteki meslekler için anlamlı fark sadece 7. sınıf öğrencilerinin doğru yanıt puanlarında bulunmuştur.

Anahtar Kelimeler: Astronomi Kavram Yanılgıları, Astronomiye Yönelilik Tutum, Cinsiyet, Astronomiye Karşı İlgi, Gelecekteki Meslek



Canım Anneme, Babama ve Babaanneme

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## **LIST OF ABBREVIATIONS**

MTAC: The Misconceptions Test About Astronomy Concepts

AAS: Astronomy Attitude Scale

## **CHAPTER 1**

### **INTRODUCTION**

The theory of constructivism is based on the learner's mental structures, beliefs on knowledge construction, meaningful context, and previous experiences and knowledge (Jonassen, 1991). According to this theory, knowledge cannot be transmitted directly from teachers and textbooks into students' minds. Students build up their knowledge through their experiences by making connections between previous knowledge and new concepts (Good & Brophy, 1994). As such, they can explore new information, compare this new information with older information that they have gained, and transform it. In this way, students act as active agents in the information acquisition process (Bada & Olusegun, 2015). Channelling students' prior knowledge and creating comparisons between current and older information are essential processes for constructivism because they can assist students in comprehending new concepts meaningfully (Baviskar, Hartl, & Whitney, 2009).

Making learning meaningful is essential for students to understand scientific concepts during science courses. Research has shown that meaningful learning of scientific concepts enables students to use these new concepts in solving problems in other courses and brings new insights into daily life experiences (Goldman & Pellegrino, 2015). Moreover, students can transfer this knowledge into future learning opportunities (Mayer, 2002). Researchers have argued that misconceptions about a variety of scientific concepts are among the most significant problems impeding students' effective learning (Köse, 2008). Specifically, studies conducted at the middle school level determined that students possessed misconceptions on concepts such as the human body (Wandersee, Mintzes, & Novak, 1994), energy (Çoban, Aktamiş, & Ergin, 2007), light concepts (Koray & Bal, 2002), heat and

temperature (Erickson, 1979) and earth science (Cin, 2007; Uğurlu, 2015). In present study, middle school students' misconceptions about astronomy concepts were investigated by using four-tier misconception tests.

Students with a positive attitude toward science are more willing to pursue a science career in the future (Osborne, Simon, & Collins, 2003). Namely, attitudes towards science are considered students' science-related decisions regarding learning objectives such as completing homework and attending class (Abell & Lederman, 2007) and there is a link between students' attitudes toward science and their academic performance (McCraw & Patel, 2011). Gender, personality, professors, culture, and other variables all have an impact on students' attitudes towards science (Osborne, et al., 2003). In the current study, 6th and 7th grade students' attitudes towards astronomy were examined based on five sub-factors: liking, self-confidence, being interested, application, and daily life. Besides, the relationship between 6th and 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy were investigated.

Misconceptions are hard to modify, persistent, and cannot be overcome with traditional teaching methods (Fisher, 1985). Misconceptions can hinder subsequent learning because they are embedded in a conceptual framework (Novak, 1988). Therefore, misconceptions should be corrected as a whole to make way for learning concepts in a meaningful way. To accomplish this, it is crucial to figure out how to identify the students' misconceptions. Students' misconceptions can be identified and corrected using the instructional approaches that comprise the constructivist learning approaches. The aforementioned approach involves the use of conceptual change methods that reconfigure or alter students' previous misconceived knowledge (Karpudewan, Zain, & Chandrasegaran, 2017). For a successful conceptual change, students must be dissatisfied with previously learned concepts, whereas new scientific concepts must be understandable, reasonable, and efficient (Posner, Strike, Hewson, & Gertzog, 1982). In this process, teachers play an important role. After determining the students' misconceptions, teachers must select the appropriate teaching methods to rectify them. It is necessary to create conflict in

students' minds as it allows them to think critically both about their previous and new concepts. In this way, students can have a chance to either abandon or modify their misconceptions and, as a consequence, this approach to learning enables students to achieve expected learning outcomes (Knowles, Holton, & Swanson, 2005).

To test students' misconceptions, several diagnostic techniques have been created and used. Commonly used tools are concept maps, open-ended questions, interviews, traditional multiple-choice tests, and multi-tier tests that include two-tier, three-tier, four-tier, and five-tier (Kaltakçı, 2012). Each of these tools has its advantages and disadvantages. For example, even though interviews and concept maps provide detailed information regarding students' cognitive structures and offer an in-depth look into how they think and what they feel about the concepts, time is needed to conduct them and analyze the data (Kaltakci- Gurel, Eryılmaz, & McDermott, 2015). Traditional multiple-choice testing is the most widely used of these tools because the administration and development process of multiple-choice tests are more straightforward compared to other diagnostic tools (Tamir, 1990). However, because students may choose the correct answer by chance, not all correct responses necessarily reflect a clear understanding of the subject. As such, not every incorrect choice reveals students' misconceptions. Lack of knowledge, negligence, and chance factors can bring about further complications in the process of multiple-choice testing (Peşman & Eryılmaz, 2010). These problems have prompted researchers to develop multi-tier tests such as the two-tier. For instance, two-tier tests take advantage on multiple-choice tests because the second-tier question determines the reason for answers that students give in the first tier. As such, the second tier contains a collection of justifications for the answers of the previous tier. However, these tests have some limitations for differentiating misconceptions from a lack of knowledge (Kaltakci et al., 2015). Also, Griffard and Wandersee (2001) stated two-tier tests exaggerate the rate of misconceptions as the information gap is indistinguishable from two-tier tests. Thus, using three-tier misconception tests is more reliable and valid for differentiating correct understanding/lack of understanding from

misconceptions because they can identify a lack of knowledge percentage with a confidence tier (Aydın, 2007). However, still in three-tier tests, students are questioned about their confidence in both the first and second tiers of three-tier tests. This could lead to an underestimation of the extent of the misunderstanding.

In regards to multi-tier tests, four-tier tests eliminate most of the problems of other multi-tier tests and establish superiority over them. They can identify students' misconceptions with more clarity since they can detect the rate of knowledge with confidence tiers (Kaltakci et al., 2015). The four-tier test works as follows: the first tier presents a common multiple-choice question; the second tier includes a question on whether students were confident in answering the first tier; the third tier asks the students to provide reasoning for the answer given in the first tier; the four and final tier includes a question asking if students remained confident in their answer after the third tier. If student chose an answer which indicates misconception in the first tier, next student is sure about the first tier, then selects the related reason for the answer, and finally the student again sure about the answers for the third tier, it can be considered students have misconception.

Unlike three-tier tests, four-tier tests include the level of answer confidence and level of reason confidence, so they prevent correct scores to be overestimated and underestimate the proportions of a lack of understanding (Kaltakçı, 2012). Thus, in the present study, four-tier test was developed and used to identify middle school students' misconceptions about astronomy concepts in the most accurate way.

### **1.1 Misconceptions about Astronomy Concepts**

Many studies have found that students struggle to comprehend astronomical phenomena (Baloğlu & Uğurlu, 2005; Frede, 2007; LoPresto & Murrell, 2011; Ünsal, Güneş, & Ergin, 2001) as the discipline of astronomy needs students to create sophisticated and dynamic mental models. This complexity is due to the necessity to sense the movement of three-dimensional (3D) objects in three-dimensional (3D) space, and also the

capacity to project their points of view to locations other than the Earth's conventional reference points, such as horizons (Parker & Heywood, 1998). As a result, students can develop concepts about astronomical phenomena that contradict currently accepted scientific explanations, causing misconceptions. Many research works have been carried out both abroad and in Turkey to detect students' misconceptions about astronomy, such as the Earth ( e.g., Dunlop, 2000; LoPresto & Murrell, 2011; Ünsal, Güneş, & Ergin, 2001); the Moon and its phases (e.g., Frede, 2007; Göncü, 2013; LoPresto & Murrell, 2011; Sadler, 1992; Trumper, 2004), the seasons ( e.g., Frede, 2006; Kalkan & Kiroğlu, 2007; Küçüközer & Bostan, 2010; ), meteor showers (e.g., Bektasli, 2014; Kanlı, 2014; Küçüközer, Bostan, & Işıldak, 2010); and lunar and solar eclipses ( e.g., Küçüközer, Bostan, & Işıldak, 2010).

Students have the most misconceptions about the seasons and the phases of the Moon among these concepts. To illustrate, the most widespread misconception regarding the seasons is that they are brought on by the Earth's position of the Sun (the distance theory). As such, summer is when the Earth approaches the Sun, and winter is when Earth moves away from Sun (Atwood & Atwood, 1996; Frede, 2006; Kalkan & Kiroğlu, 2007; Küçüközer, Bostan, & Işıldak, 2010; Trumper, 2000, 2001a). The phases of the Moon are one of the most well-known natural events, yet it is also one of the most misunderstood (Trundle, Troland, & Pritchard, 2008; Trundle & Troland, 1996). Such misconceptions about the reason for the phases of the Moon such as "the Moon enters the clouds" (Baxter, 1989; Göncü, 2013) and "the Moon enters the shadow of the Earth" (Frede, 2007; Göncü, 2013; LoPresto & Murrell, 2011; Sadler, 1992; Trumper, 2014) were determined. Misconceptions about astronomy concepts that have been found by earlier studies were presented in Table 1.1 The table present the data collection tool as well. The participants were students from different grade levels and both teachers and preservice teachers.

Table 1-1 Common Misconceptions About Astronomy Concepts

| Author(s)                             | Participant                              | Data-Gathering Method    | Misconceptions   |
|---------------------------------------|--|--------------------------|--|
| Baxter (1989)                         | Students in Grade 4-10                   | Interviews               | Since the Moon has entered the clouds, the phases of the Moon have occurred.<br>The phases of the Moon occur when the moon enters the Earth's shadow.  |
| Atwood and Atwood (1997)              | Pre-Service Elementary Teacher           | Interviews               | Seasons are caused by the Earth's distance from the Sun changing.  |
| Trumper (2001)                        | Junior High School Students              | Multiple choice test     | The Moon's axis does not rotate.<br>The phases of the Moon occur when the moon enters the Earth's shadow.  |
| Frede (2007)                          | Pre-Service Elementary Teacher           | Open ended questionnaire | Seasons are caused by the Earth's distance from the Sun changing.<br>The phases of the Moon occur when the moon enters the Earth's shadow.   |
| Kanlı (2014)                          | Pre-Service Science Teachers             | Three-tier test          | Since the Moon has entered the clouds, the phases of the Moon have occurred.<br>The Sun is not a star because it is a part of the solar system<br>Seasons are caused by the Earth's distance from the Sun changing.                            |
| Küçüközer, Bostan, and Işıldak (2010) | Preservice Mathematics Teachers          | Multiple choice test     | Due to the Earth's axis inclination, lunar and solar eclipses do not occur every month.  |
| Göncü (2013)                          | 5th And 7th-Grade Middle School Students | Three-tier test          | The Moon's axis does not rotate.<br>Meteors are meteors stars that fall from the sky.<br>The phases of the Moon occur when the Moon enters the Earth's shadow.<br>Since the Moon has entered the clouds, the phases of the Moon have occurred. |

According to the information presented in Table 1, interviews, open-ended questionnaires, three-tier tests, and mostly multiple-choice tests were used to identify the participants' misconceptions about astronomy. Both qualitative and quantitative data analyses have been utilized. Also, while three-tier tests and multiple-choice tests



were used for both middle and high school students, the open-ended questionnaire method was used for undergraduate students. Additionally, studies that were done abroad did not benefit from three-tier tests to determine misconceptions regarding astronomy. According to Table 1.1, interview and three-tier misconception tests were used for middle school students to better understand how intensely they held onto these misconceptions.

Furthermore, the studies presented in Table 1.1 examined the participants' misconceptions regarding the Sun, the Moon, meteor shower, lunar eclipse, solar eclipse, and season. These observed misconceptions showed similar patterns in Turkey and other countries. According to Turkey's current science curriculum (Ministry of Education, 2018), the earth and universe units covered astronomy concepts such as the shape of the Earth, the Sun, the Moon, phases of the Moon, stars, constellations, lunar eclipse, solar eclipse, meteor, season, and features of the planets (Table 1.2). In this study, a misconception test for astronomy concepts (MTAC) was developed for 6th and 7th grade students. The reason for this is twofold. First, as it was seen from Table 1.2, most of the astronomy concepts are covered in these grade levels. Second, the structure of the Sun, the features of the planets, the Moon, the phases of the Moon, lunar and solar eclipses, and meteors are all concepts that both 6th and 7th grade students are familiar with. As a result, MTAC was developed using these concepts. Because using these concepts allows researchers to measure misconceptions with more than one question involving different contexts, it helps to minimize the noise of false-negative scores (Hestenes & Halloun, 1995).

Table 1-2 Astronomy Concepts Covered in Middle School Science Curricula (2018)

| Grade levels     |                  |                 |                 |
|------------------|------------------|-----------------|-----------------|
| 5th              | 6th              | 7th             | 8th             |
| The structure of |                  |                 |                 |
| The Sun          | The Solar System | Satellite       |                 |
| The Motion of    |                  | Planet          | Space Pollution |
| The Sun          | Meteor           | Sky Observation |                 |
| The Structure of | Meteoroid        | Tools           | Seasons         |
| The Moon         | Asteroid         | Star            |                 |
| The Motion of    | Solar eclipse    | Constellation   |                 |
| The Moon         | Lunar eclipse    | Galaxy          |                 |
| Phases of The    |                  | Black Hole      |                 |
| Moon             |                  |                 |                 |

## 1.2 Attitudes Toward Science

In the particular study, according to Aiken (2000), attitude means "a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (p.9). A person who has a positive attitude towards anything, for example, is more inclined to respond positively, be closer to it, and support it. A person with negative attitudes toward an object, on the other hand, will at most be indifferent to the subject, but will almost always strive to find flaws with it (Aydın, 2000). The feelings, ideas, and values held about a subject, such as the enterprise of science, the teaching of science, and the impact of research on society, are all examples of attitudes toward science (Osborne, et al., 2003, p.1053). There are several approaches to measuring attitudes in science education (Gardner, 1975) with an attitude scale being the most common method to measure students' attitudes towards science (Kind, Jones, & Barmby, 2007).

Studies have also shown that attitude can be influenced by different variables such as academic achievement (Ingram & Nelson, 2006; Ma & Kishor, 1997; Osborne & Collins, 2000) personal preferences and behaviour (Glasman & Albarracin, 2006), and one's motivation (George, 2006; Hendricks, 1997). A person's attitude towards any object or person is likely to affect their interactions with that person or object. By contrast, when people have negative attitudes towards a subject, it can be learned slowly, if at all, and so precludes any advancements in that subject. Thus, people's achievement in a particular subject can be determined by their attitude towards it, and the relationship between academic achievement and attitude is seen as an important issue that permeates much of the literature (Osborne, et. al., 2003).

Some researchers argue that students' achievement and their misconceptions about science concepts are directly affected by their attitudes towards science (e.g., Çam, Topçu, & Sülün, 2015). When students had negative attitudes towards science, they tended to have more misconceptions about scientific concepts than students with a positive attitude towards science (Bajah, 1998). More specifically, Bektaslı (2016) investigated the association between misconceptions about astronomy and their students' attitudes toward astronomy in a study with 78 preservice teachers. During the previous semester, the test group took a two-credit astronomy course. To gather information, tests were conducted on misconceptions about astronomy concepts and attitudes toward science. Moreover, three students were interviewed and their conceptual test results compared to see if there was a link between having a low, medium, or high degree of positive attitudes. According to the result, students who had moderate to high levels of positive attitudes showed a greater understanding of astronomy than students who had a more negative attitude towards astronomy. These findings indicate that when students' attitudes tend to be negative, they are more likely to hold more misconceptions than those who hold more positive attitudes.

Kalkan and Türk (2015) developed the Attitude Astronomy Scale (AAS) to determine middle school students' attitudes toward science. The instrument included five sub-factors regarding attitude towards astronomy (liking, self-confidence, being interested, application, and daily life). AAS had a Cronbach-Alpha consistency

coefficient of .912. AAS was utilized in this current study to assess middle school students' attitudes towards astronomy concepts. In this study, the relationship between attitudes towards astronomy and misconceptions about astronomy concepts was also investigated. In this sense, it was anticipated that students with a positive attitude towards astronomy would have fewer or no misconceptions about astronomy. Furthermore, the association between attitude towards astronomy and correct responses to astronomy concepts was investigated with a similar interest. It was assumed that students' correct responses to astronomy concepts are likely to be higher if they have a positive attitude towards astronomy.

### **1.3 Gender Differences in terms of Misconceptions about Astronomy Concepts and Attitudes Towards Astronomy**

In the present study, the gender differences in terms of attitudes towards astronomy and misconceptions about astronomy concepts were investigated. Based on the literature, there are some conflicting results related to the disparity between male and female students' attitudes towards science. Even though many studies have found no difference between male and female students' attitudes towards science (Çokadar & Külçe, 2008; Sofiani, Maulida, Fadhillah, & Sihite, 2017), male students exhibited more positive attitudes towards science than female students, according to certain research (Greenfield, 1996; Simpson & Oliver, 1985). As opposed to these studies, some studies found that female students had more positive attitudes towards science than male students (Mihladiz, Duran, & Doğan, 2011; White, 1999). More specifically, Dewitt and Bultitude (2018) conducted research into students' attitudes towards astronomy and their opinions about astronomy careers. The number of participants was about 8000 students across 11 European countries, and the students ranged in age from 9 to 16. The findings showed that the male students had more positive attitudes towards astronomy than those of female students in northern European countries, whereas the gender differences were not significant in eastern European countries. Marusic and Hadzibegovic (2018) conducted a study to examine

16-18-year-old high school students' attitudes towards astronomy in Bosnia Herzegovina and Croatia by using a self-reported questionnaire. The findings of this study demonstrated that students in both countries had similar attitudes towards astronomy regardless of their gender.

Topal (2018) conducted a study to investigate 5th and 12th grade levels of Turkish students' misconceptions about science concepts with regards to gender and found no significant difference between male and female students' misconceptions about general science concepts. Similar to the current study, Türkmen (2015) carried out a study to analyse 5th grade students' understanding of basic astronomy concepts. According to the findings of this study, female students scored significantly better than male students.

Since the mentioned studies indicated contradictory findings regarding gender differences, more studies are needed to better comprehend gender differences in understanding and misconceptions about astronomy concepts and attitudes towards astronomy. In the present study, these variables were investigated together to provide a more holistic understanding.

#### **1.4 Interest in Astronomy in terms of Misconceptions about Astronomy Concepts and Attitudes Towards Astronomy**

Intrinsic motivation is beneficial to learning (Deci & Ryan, 1985). When students have intrinsic motivation to learn, they are more inclined to participate in educational activities. For intrinsic motivation, interest is a critical prerequisite (Krapp, 2002). According to Wade (2001), interest in science topics was defined as "specific and relatively stable" (p.245). Additionally, "it develops over time and is associated with personal significance, positive emotions, high value, and increased knowledge" (p.245). Students' persistence in science is mostly explained by their interest in many studies. According to the findings of certain studies, interest has a favourable impact on academic achievement (Jansen, Lüdtke, & Schroeders, 2016; Scholastica, 2020)

and conceptual change (Windschitl, 2003). Lavonen, Byman, Juuti, Meisalo, and Uitto (2005) carried out a study to look into gender differences in high school students' interests in different astronomical contexts. The results revealed that the fields of interest were significantly different. Female students were more interested in learning the concepts related to stars, planets, and extra-terrestrial life, whereas male students were more interested in learning about rockets, satellites, and moon landing concepts, which were mostly related to technological studies.

Some activities, such as attending science clubs and science groups, promoted students' interest in science (Woods, 1959). Önal and Önal (2021) conducted an experimental study to see how educating astronomy utilizing augmented reality (AR) affected talented students' achievement and engagement levels. The experimental group's astronomy achievement and interest in astronomy were positively affected by AR-supported astronomy teaching activities. More research is needed to understand middle school students' interest in learning astronomy. Thus, in the present study, this variable was investigated to understand how it is related to attitudes towards astronomy and misconceptions about astronomy concepts. It was expected that when students are interested in astronomy they may have good conceptual understanding and have fewer or no misconceptions about the astronomy concepts.

### **1.5 Future Occupation in terms of Misconceptions about Astronomy Concepts and Attitude Towards Astronomy**

According to certain research, students' science experiences, skills, and interests are often related to their future careers (Sadler, Sonnert, Hazari, & Tai, 2012). When students participated in hands-on experiments in science classes, out-of-school science experiences, and had a greater interest in science, they became more inclined to choose occupations in Science, Technology, Engineering, and Math (STEM) areas (Jocz, Zhai, & Tan, 2014). Students who took part in astronomy-related educational activities in elementary or secondary school were more willing to pursue science and

technology careers, as well as participate in and actively participate in scientific studies (NRC, 1991). Berstrom, Sadler, and Sonnerth (2016) investigated the change in students' interest in astronomy careers from middle school to the beginning of high school years. They concluded that middle school students in the USA had a higher interest in astronomy-related careers and attended out-of-school activities focusing on astronomical events. Female students also showed a stronger preference for astronomy-related occupations than male students. Doğan (2020) researched to determine middle school students' future career interests at BİLSEM (Science and Art Centre). According to the outcomes of this study, 19 students were interested in astronomy and preferred to pursue their careers in the field of space sciences. Among the professionals in space, scientists and astronauts were the most preferred ones. Besides, some students wanted to be astrophysicists, astronomers, or TÜBİTAK space workers. It was concluded that students were inclined to choose professions related to space sciences when they were interested in astronomy. Students who want to get a profession in math and science can learn concepts better. Hence, fewer or no misconceptions about that may be detected. This has been supported by other research studies. Accordingly, students who approach science more positively and show an interest in it acquire more basic science knowledge and collect information related to science more meaningfully (Partridge & Greenstein, 2004). This situation may bring about scientific achievement, which is necessary for students to determine future science careers (Parker & Gerber, 2000).

Most recently, in many countries similar to Turkey, educating and increasing students' awareness of STEM careers are being emphasized in the science curriculum. Thus, more studies are needed to clarify the impacts of practices in school on achieving this goal. In the present study, attitudes towards astronomy and misconceptions about astronomy were investigated about the students' future occupations in astronomy-related areas. For this purpose, the student's future occupation was used as one of the independent variables.

## **1.6 The Purpose of the Study**

This study aims to analyze 6th and 7th grade middle school students' misconceptions about astronomy concepts and attitudes towards astronomy and to investigate relationships between the 6th and 7th grade middle school students' misconceptions about astronomy concepts and attitudes towards astronomy and differences in gender, grade level, interest in astronomy, and future occupation in terms of misconceptions about astronomy concepts and attitudes towards astronomy.

## **1.7 The Main Problem and Sub-Problems**

### **1.7.1 Main Questions and Sub-Questions**

1-) What are the 6th and 7th grade middle school students' misconceptions about astronomy concepts?

- Is there a significant difference between 6th and 7th grade middle school students' misconceptions about astronomy concepts?
- Is there a significant difference between 6th and 7th grade middle school students' correct responses about astronomy concepts?

2-) What are the 6th and 7th grade middle school students' attitude towards astronomy?

- Is there a significant difference between 6th and 7th grade middle school students' attitudes towards astronomy?

3- Is there a significance difference of 6th and 7th grade middle school students' attitudes towards astronomy in relation to gender, interest in astronomy and future occupation?

4- What are the relationships between 6th and 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy?



5- Is there a significance difference of 6th and 7th grade middle school students' misconceptions about astronomy concepts in relation to gender, interest in astronomy and future occupation?

### **1.8 Significance of the Study**

To create the Misconceptions Test About Astronomy Concepts (MTAC), many instruments developed and used in Turkey were examined. It was observed that the latest instrument was developed by Göncü (2013) as a three-tier test based on the 2006 science curriculum and was used to detect 5th and 7th grade students' misconceptions about astronomy concepts. On the other hand, Turkey's scientific curriculum has been changed twice since then. Thus, a new instrument was needed to better assess students' misconceptions. For that reason, the instrument developed in this study better addresses the science curriculum objectives. The Misconceptions Test About Astronomy Concepts (MTAC) provided a potential tool for teachers to determine their students' misconceptions. Teachers can also use this instrument to identify students' prior misconceptions about astronomy concepts. As a result, they could generate more effective lessons on earth and universe units to address misconceptions. Moreover, the test can be used as a source by other researchers to determine students' misconceptions about astronomy concepts in different parts of Turkey.

Many studies were conducted about the misconceptions about astronomy concepts in Turkey (Bolat, Aydoğdu, Sağır, & Değirmenci, 2014; Cin, 2007; Uğurlu, 2005) and these studies considered the astronomy concepts as covered in the old science curriculum. With the revision of the science curriculum (MONE, 2018), the earth and universe units are located as the first units for all grade levels. Thus, this study may provide valuable information regarding this change resulting in better learning in astronomy concepts. Teachers and educational policymakers can use the findings of this study to boost the quality of teaching and learning processes in earth and universe units. Policymakers can also utilize the findings of this study to revise the

curriculum and ensure that these misconceptions are addressed in course textbooks as well.

In this study, two variables were measured, which were misconceptions about astronomy concepts and attitudes towards astronomy. The relationships obtained between these variables can enable important information about relationships' strength and direction. Thus, teachers can consider students' attitudes and encourage them to approach the earth and universe units in a more positive manner. In addition, they can better understand if misconceptions about astronomy concepts affect attitudes towards it. Also, policymakers can consider these students' characteristics while deciding the organization and content of the astronomy concepts.

One of the main objectives of the Turkish science curriculum is to promote students' scientific career awareness and entrepreneurship skills related to science (MONE, 2018). The results of this study will assist teachers in becoming better career advisers for their students. Even though students are interested in astronomy, they may have misconceptions about the astronomy concepts. Therefore, the findings of this study may be important for teachers to eliminate these students' misconceptions about astronomy concepts without discouraging them, which may help students to follow their pursuit of a career in the field of astronomy more meaningfully.

PISA is a comprehensive assessment and evaluation study that aims to determine the literacy levels of 15-year-old students in the fields of science, mathematics, and reading. Since 2006, Turkey has always been below average in science performance compared to other countries. For example, according to the 2015 PISA report, the average score for all participating countries is 465, while the average for Turkey is 425, and Turkey ranks 54th among 72 countries in terms of students' science performance (OECD, 2016). Moreover, according to the 2018 PISA report, Turkey was below the general average in terms of science performance and ranked 32nd among 41 countries in terms of students' science performance (OECD, 2019). These findings suggest that students had difficulty in comprehending scientific concepts

during the learning process. According to several studies, scientific misconceptions are linked to student academic success and have an impact on student learning effectiveness in science fields. As a result, if students struggle to master a particular science idea, resulting in poor science performance, they will have difficulties learning or comprehending comparable scientific concepts in the future (Galvin, Mooney, & O'Grady, 2015; Kirbulut & Geban, 2014).

In addition to PISA, TIMSS aims to evaluate the knowledge and skills of 4th and 8th grade students in mathematics and science. On this exam, there are questions about science subjects. In contrast to TIMSS conducted in 2015, the students' achievement in science was higher in the TIMSS conducted in 2019 and, for the first time in 2019, Turkey remained above the general average. In detail, Turkey's performance in the fields of chemistry (516) and physics (518) is higher than its performance in biology (513) and earth sciences (509). On the other hand, the performances of the students in the Turkish sample in biology (75 items) and earth sciences (42 items) are significantly below their general science performances. In this case, it shows that students have difficulties understanding this area, and as a result, it may affect the learning situation. All in all, this study can be useful for educators as it shows where students have misconceptions about astronomy.

## **1.9 Definitions of Important Terms**

**Middle school students:** The students enrolled in 5th to 8th grades are considered middle school students in Turkey.

**Astronomy:** It is an interdisciplinary discipline that is linked to other sciences and may be revised and improved based on new information by qualitatively and quantitatively investigating the structure and movements of celestial objects (Düşkün, 2011).

**Misconception:** “Any strongly held idea that is incompatible with generally accepted scientific notions is referred to as a misconception” (Comins, 2001, p.56).

**Misconceptions Test About Astronomy Concepts (MTAC):** It is an instrument that measures astronomy misconceptions of 6th and 7th grade middle school students.

**Attitude:** “A learned predisposition to respond positively or negatively to a specific object, situation, institution, or person” (Aiken, 2000, p.8)

## **CHAPTER 2**

### **LITERATURE REVIEW**

The chapter on literature reviews is subdivided into nine parts. In these parts' constructivism, misconceptions, misconceptions about astronomy concepts, misconception diagnosing methods, attitudes, attitudes towards astronomy, gender, interest in astronomy, and future occupation are presented.

#### **2.1 Constructivism**

Constructivism "is the philosophy or belief that learners create their knowledge based on interactions with their environment, including their interactions with other people" (Draper, 2002, p. 522). Constructivism theory emphasizes students' real-world experiences, prior knowledge, mental structures, knowledge construction beliefs, and meaningful knowledge construction (Jonassen, 1991). Piaget developed a knowledge theory consisting of assimilation, accommodation, and equilibrium (Sjøberg, 2010), and these three processes affect learners' cognitive development through knowledge construction (Wadsworth, 2004).

Knowledge cannot be transmitted directly from textbooks or teachers into the students' minds. On the contrary, students build their understanding through their experiences in daily life by making connections between their previous knowledge and newly learned concepts or gained experiences. The mechanisms of assimilation and accommodation can take place to achieve this knowledge construction process (Bada & Olusegun, 2015). To be clear, assimilation means that the individual can understand the newly encountered situation by trying to place objects and events within the relevant mental structures that already exist in his or her mind. However, sometimes an individual develops new schemes to explain and make sense of the

situation he or she encounters or tries to change the scope and qualifications of his / her existing schemes to behave in the new situation. This process of knowledge construction is called accommodation. Assimilation and accommodation are inextricably linked; when a person interacts with sensory information, not only assimilation but also accommodation occurs. Equilibrium is also the continuous adjustment between assimilation and accommodation (Abell, Appleton, & Hanuscin, 2013).

One of the main characteristics of constructivism is that it elicits prior knowledge. All information is gathered concerning the student's prior knowledge, according to constructivism (Sewell, 2002). When the teachers are unaware of the students' prior knowledge of the concepts, they cannot teach the new knowledge effectively. That's why, during the lesson, they should care about the students' previous knowledge. In addition to that, Ausubel (1968) also stressed the importance of revealing information that students had previously acquired. According to him, the most critical factor affecting learning is students' prior knowledge. When students integrate newly learned concepts to existing knowledge, they are engaging in meaningful learning. However, in some cases, students may have problems linking previous and newly learned knowledge. In one of these cases, students' previous knowledge may contradict the scientific explanation. This contradicted previous knowledge, which is called a misconception. Misconceptions can impede students' learning processes. Thus, teachers should pay extra attention to students' misconceptions and try to rectify students' misconceptions to help them attain meaningful learning (Ilyas & Saeed, 2018).

The other main characteristic of constructivism is creating cognitive conflict (Baviskar, Hartle, & Whitney, 2009). Creating conflict is related to Piaget's previously mentioned theory of cognitive development. As such, when the learners encounter the new knowledge, they may assimilate it into an existing schema, but when they are unable to explain the new information with the current schemas, disequilibrium or cognitive conflict may occur. As a result, they can create a new schema and accommodation takes place (Abell, et al., 2013). The learners are

expected to apply the newly acquired knowledge to a novel situation and establish further connections so that the information structure can be permanent.

Creating cognitive conflict is a strategy that obstacles students' misconceptions by creating equilibrium between previous knowledge and newly learned knowledge (VandenBerg & Grelle, 2009). Posner, Strike, Hewson, and Gertzog created the conceptual change model (1982), and they pointed out that establishing cognitive conflict with existing conceptions through dissatisfaction is the fundamental and initial step in attaining conceptual change. During this stage of dissatisfaction, students recognize that they need to rearrange, restructure, or change their current views or concepts. They must also recognize the need for change and be inclined to make it (Limon, 2001). The new concepts must be understandable, credible, and beneficial for the successful conceptual change (Posner et al., 1982). Besides, since the process of conceptual change does not involve each concept similarly, it is required to apply a variety of conceptual change methods, such as concept cartoons and analogies, that consider students' experiences in this process (Küçüközer, et al., 2010).

As of 2005, the constructivist learning approach has been adopted in the science curriculum in Turkey (MONE, 2005). After that, the Turkish science curriculum was changed twice, in 2013 and 2018. The curriculum adopted in 2013 was focused on the inquiry-based learning strategy in which the student is responsible for his learning, actively participates in the process, and provides the opportunity to construct knowledge in his mind (MONE, 2013). In addition, the science curriculum currently implemented in Turkey adopts the inquiry-based constructivist learning approach as well as science, engineering, and entrepreneurship practices (MONE, 2018). With the change in curriculum in 2018, science curriculum has begun to be implemented at grade levels 3rd–8th grades and astronomy subjects increase and deepen as the education level progresses. That is, as one's education grows, astronomy subjects get more complex and in-depth. It has been stated that if students cannot master astronomy concepts well in middle school, they will have difficulty in learning related subjects in high school and university education. At all levels of the

classroom, the goal is to learn achievements connected to astronomy topics in a relevant way (Küçüközer, 2007).

From the third grade onward, students must thoroughly understand each astronomy concept because they acquire knowledge exponentially and must associate new knowledge with old knowledge (preliminary knowledge or experiences) that forms the basis of meaningful learning. For example, lunar and solar eclipse concepts are addressed in 6th grade, and to study these concepts meaningfully, a strong understanding of the shape of the Earth, the structure of the Sun, the motion of the Moon, and the phases of the Moon is required. Therefore, if students have misconceptions about astronomy concepts, they should be cleared up to provide them with meaningful learning.

## **2.2 Misconceptions**

Students form their ideas and opinions about events by observing the natural world (Baxter, 1989). Many of these ideas and opinions that students have acquired through their experiences can contradict accepted science concepts (Sewell, 2002). This contradiction is referred to as misconceptions (Fisher, 1985).

It is critical to realize that all preconceptions and errors are not regarded as misconceptions (Klammer, 1998). A misconception does not arise from a lack of knowledge. On the contrary, the misconception is an incorrect or incomplete understanding of the concept. In other words, misconceptions are a subset of errors, which means all errors are not misconceptions. When students have a misconception, their understanding of science is not true or incomplete, but it is true for them. Despite being wrong, it works for students and helps them understand the world (Eryılmaz & Sürmeli, 2012).

According to the National Research Council (NRC), there are five types of misconceptions (1997). These are; preconceived notation is an idea or opinion that can be created by one's everyday experiences. Non-scientific beliefs include



conceptions that are learned from non-scientific resources. Conceptual misunderstandings occur when science concepts are not presented in a way that causes students to confront preconceived notions or non-scientific beliefs. Vernacular misconceptions arise from a misunderstanding about the meaning of the world in accordance with science and everyday life. Factual misconceptions occur when someone learns a fact wrongly at an early age and persists throughout his/her adulthood (p.28). In the present study, the students could get misconceptions about astronomy concepts from the kinds of misconceptions mentioned above. To illustrate, the misconceptions that were defined about the phases of the moon ("As the Moon enters the shadow of the Earth, the phases of the Moon occur") could be factual misconceptions that students gain at an early age.

Moreover, misconceptions are formed by other resources. Earlier empirical research found that the formation of misconceptions can result from textbooks, teachers' language, parents, students' groups, cultural beliefs, media, and socioeconomic factors (Patil, Chavan, & Khandagale, 2019). Researchers emphasized that among these, textbooks (Devetak & Vogrinc, 2007) and teachers (Gudyanga & Madambi, 2014) are the major factors in the formation of misconceptions.

Textbooks are the sources of students and teachers for the teaching and learning process. However, they can contain unclear, oversimplified figures, pictures, and complex language for students (Gudyanga & Madambi, 2014). For example, astronomical events generally take place in 3-D space, but textbooks are composed of 2-D pictures and diagrams about astronomy concepts. Hence, mental representation of 2-D models and graphs can be difficult, especially for young students to interpret appropriately (Cin, 2007). Researchers argued that the textbooks picture the solar system as a series of flat circles, and the Sun is mostly displayed in the centre. Also, despite the fact that the Sun is significantly larger than the Earth and can fit a million pieces of Earth inside it (Bekdaşlı, 2016), the distances between the planets are frequently ignored or shown incorrectly. Hence, teachers should utilize 3-D modelling in addition to textbooks to help students understand astronomy concepts.

Ineffective teaching can cause misconceptions. In that sense, teachers play a vital role in propagating students' misconceptions. If the teacher explains the abstract concepts instead of using visualization and analogy, students can create misconceptions. According to the constructivist approach to teaching and learning, observing, discovering, doing, and experiencing are needed for students to comprehend science concepts meaningfully. Otherwise, just by using traditional teaching methods, rote learning can take place more often, and students can memorize the given information rather than achieve meaningful learning (Ercan, Bilen, & Ural, 2016). In addition to that, the teachers' misconceptions bring along students' misconceptions. As such, students can promote misconceptions about concepts when teachers have misconceptions about the concepts. Also, if teachers cannot know how to identify students' misconceptions and cannot determine students' misconceptions before teaching, students can gain misconceptions. Considering all of this, teachers should have a clear understanding of scientific concepts (Gudyanga & Madambi, 2014).

Many studies have been published that show a link between social status and academic achievement (Barry, 2006). Families with a higher socioeconomic position are able to purchase more books and educational toys. These aid in the cognitive development and growth of children (Saifi & Mehmood, 2011). Also, these families can require their children to take private lessons or courses for them to attend schools that provide a higher quality of education (Savaşçı & Tomul, 2012). These opportunities enable students to better comprehend the concepts that are related to lessons and to be academically successful in their lessons. For that reason, these students may not have misconceptions. On the other hand, socio-economic status can cause misconceptions. Koçyiğit's (2013) study showed that students who are in low socio-economic status have more misconceptions about static electricity than students who are in high socio-economic status.

Misconceptions are difficult to change, persist, and cannot be eliminated through traditional teaching methods (Fisher, 1985; Sungur, Tekkaya, & Geban, 2001). When students have ideas that contradict scientific ideas, they are unable to learn

the new concepts because they are unable to connect their prior knowledge to the new knowledge (Onder & Geban, 2006). Although students have misconceptions in any discipline, their misconceptions in the science area are often investigated. In the literature, there are plenty of studies that are related to misconceptions about physical, biological, and chemical phenomena. Specifically, there are also lots of studies devoted to showing students' misconceptions about astronomy concepts.

### **2.3 Misconceptions about Astronomy Concepts**

Astronomy is characterized by a scientific discipline that encompasses multiple subjects like physics, chemistry, geology, and biology, in addition to math and geometry. That's why, dissociating astronomy from the physical sciences is quite difficult (Parker & Heywood, 1998). Research indicates that astronomy is the most interesting subject among other science topics, especially for primary school students (Dede, 1995). Cartoons, science fiction literature, textbooks, documentaries, friends, teachers, family, photographs, and periodicals are all sources of astronomy concepts for them. Students get their knowledge of astronomy by making observations in everyday life and establishing communication with others (Kikas, 2003). Unfortunately, much of what students have learned throughout their experience conflicts with scientific explanations, leading to misconceptions (Sewell, 2002). Based on the literature, there are plenty of studies that have identified misconceptions about astronomy concepts among students of different age groups and cultures.

Understanding the shape of the Earth, as well as the relative sizes and distances to the Sun and the Moon, is essential for understanding other astronomical concepts and events (Treagust & Smith, 1989). Some research that examined the Earth and related concerns showed that students had widespread misconceptions about the shape of the Earth. Bolat, Aydoğdu, Sağır, and Değirmenci (2014), for example, used a test with six open-ended questions and students' drawings to detect misconceptions about the Sun, the Earth, and the Moon concepts in their study. The group consisted

of 40 students in fifth grade. The researchers concluded that most students draw the Earth's shape like a sphere, 5% of students draw the Earth's shape as an ellipse, and only 15% of students correctly draw the Earth's shape. Similarly, Ünsal, Güneş, and Ergin (2001) conducted a study with 170 undergraduate students from 34 different branches to examine astronomy knowledge. An open-ended questionnaire on basic astronomy concepts was used to assess astronomy knowledge. The questionnaire is divided into five sections, each with 31 questions. They revealed that the misconception of the shape of the Earth is an ellipse (59%), and a sphere (21.1%). Only 13.5 % of those who answered the test correctly identified the Earth's shape as the geoid. As it can be seen in the research, not only elementary and middle school students, but also university students had misconceptions about the shape of the Earth. It is possible that when they were young, their misconception about the Earth's shape was not corrected. Thus, these students may have a problem understanding other astronomy concepts, like the phases of the Moon.

The phases of the moon are a well-known natural phenomenon, but they are the most misunderstood concepts in astronomy (Trundle and Troland, 1996) because they are one of the most abstract topics in science (Callison, 1993). Baxter's study, which included children whose ages ranged from 9 to 16, identified some misconceptions about the phases of the Moon which are: " Clouds cover the part of the moon that we cannot see, planets cast shadows on the part of the moon that we cannot see. The shadow of the Sun falls on the Moon, blocking our view of it, the shadow of the Earth falls on the Moon, blocking our view, the phases are explained in terms of the portion of the illuminated side of the Moon visible from the Earth" (p. 509). According to him, there are several misconceptions concerning Moon phases, the most popular of which is that the phases of the Moon occur when the Moon enters the Earth's shadow (Stahly, Krockover, & Shepardson, 1999).

Using multiple-choice tests regarding astronomy concepts, Sadler (1992) undertook a study with 1414 high school students in the United States to detect misconceptions about astronomy concepts. The results were analysed by classical test theory. Besides, multiple regression was used to reveal the relationships

between demographic and school factors and students' misconceptions. According to the results, most of the students, 41% (579 of 1414), believed that the Moon had changed shape since it moved out of the Earth's shadow. Also, 27% (381 out of 1414) of students believed that the changing Moon's shape occurs because it moved out of the Sun's shadow. Trumper's (2014) study came up with a similar result. His research looked into the understanding of astronomy concepts by 76 university students, one of which was related to Moon phases. A multiple-choice test with 19 questions was used to collect the information. According to his findings, 47.4 % of students believe that the Earth is involved in producing Moon phases by covering sections of the Moon with its shadow. Likewise, Frede (2007) did a study to examine the conceptual comprehension of astronomy concepts such as the day/night cycle, solar system composition, and seasonal changes among 50 pre-service elementary French teachers. An openly written questionnaire was utilized to obtain the teachers' views on astronomy. Seasons, phases of Moon, meteor showers, and pole stars were among the prevalent misconceptions discovered in the study. According to the result, 34 % of participants thought that when the Moon enters the Earth's shadow, the phases of the Moon occur.

Studies conducted in Turkey have shown superior outcomes to three earlier studies conducted in other countries. For example, Kanlı (2014) conducted a study with 117 pre-service physics teachers, 97 pre-service science teachers, and 174 in-service teachers to detect misconceptions about astronomy concepts. The data was collected using the three-tier test. The result shows that the participants had a lot of confusion about the phases of the Moon. According to the result of the study, when the Moon enters the Earth's shadow, the phases of the Moon occur (physics teachers: 13%, science teachers: 18%, in-service physics teachers: 15%). A similar misconception was highlighted in a study conducted by Ozkan and Akçay (2016), which examined the conceptual comprehension of astronomical concepts, including Moon phases, using a sample of 118 preservice science teachers. Data was gathered using the Astronomy Conceptual Questionnaire, which consists of 13 open-ended surveys as well as semi-structured interviews. According to their

findings, 20.0 % of freshmen, 19.5 % of sophomores, and 14.9 % of juniors believe that the phases of the Moon occur when the Moon enters the Earth's shadow. As can be seen, regardless of age and level, both students and teachers may have misconceptions about the phases of the moon. In addition to the two previously mentioned misconceptions, some studies presented the misconception about the Sun. For example, Direkçi (2014) conducted a study with 5th grade students to investigate mental images of the Earth, the Sun, and the Moon concepts. The sample involved 30 students. Data was collected with semi-structured interview forms and evaluated using a phenomenographic research. The result showed that some students defined the Sun as a planet instead of a star. Similarly, Serttaş and Türkoğlu (2020) carried out a study to diagnose 7th grade students' misconceptions about the universe, the Sun, comets, and constellations. Data was collected through concept cartoons and interviews. According to their results, 20 students defined the Sun as a medium-temperature planet.

Bostan (2008) did a study to determine different age groups of students, which included middle school students whose grade levels were 4th, 5th, and 7th, high school students whose grade level was 2nd, and university students whose grade levels were 1st, 2nd, 3rd, and 4th class knowledge levels about some basic astronomy concepts, one of which was the frequency of lunar and solar eclipses and meteor showers. The information was obtained via open-ended questionnaires and semi-structured interviews performed by students in each grade level. The questions that were related to eclipses and meteor showers were not asked by 4th and 5th grade students. According to the result, the most common misconception about the frequency of lunar and solar eclipses is that "it does not happen every month because the rotation speeds of the Earth and the Moon are different from each other." This misconception was seen more frequently in the 7th grade (34%) grade middle school students. Moreover, other misconceptions about meteor showers were determined as meteor showers mean the displacement of stars or comets. This misconception was seen more frequently in 7th (64%) grade elementary school students and high school students (17.5%) than university students.

Similarly, Şahin, Bülbül, and Durkan (2013) investigated the impact of conceptual change tests on eliminating students' astronomy misconceptions. The participants include 22 7th grade students. Data was collected by using a questionnaire that included 12 concepts cartoon. Also, the 5E teaching method was used. The pre-test was used with conceptual change tests before the instruction, and after the instruction, the post-test was used with conceptual change tests. After gathering all the data, the data was analyzed with an independent t-test. Common misconceptions were determined. They are that "the Sun is not a star" and that "meteor showers are caused by star displacement."

#### **2.4 Misconceptions Identification Tools**

Based on the literature, there have been numerous studies that indicate how misconceptions impact students' learning and comprehension of subjects (Voska & Heikkinen, 2000). Thus, students' misconceptions must be identified in order for them to understand topics and learn meaningfully. The first step in eliminating misconceptions is to identify them (Carle, 1993). To assess students' misconceptions, a variety of misconception diagnostic techniques have been created and deployed. On the other hand, interviews (Osborne, 1980), concept maps (Novak, Gowin, & Johansen, 1980), and multiple-choice assessments (Hestenes et al., 1992) are commonly utilized to determine students' misconceptions.

Hammer (1996) creates an analogy that includes the exploration of personal knowledge and the diagnosis of diseases by doctors. When doctors diagnose diseases correctly, they can use effective treatment for their patients. However, if they do not find the correct diagnosis, doctors provide treatments that are not only ineffective but also damaging to patients. Such an incorrect diagnosis creates terrible consequences. With this analogy, the importance of diagnosing can be seen. That's why accurately determining students' misconceptions is vital to eliminating these misconceptions. In this way, to appropriately determine students' misconceptions, valid and reliable tools should be employed (Kaltakci-Gurel, et al., 2015).

All tools have advantages as well as disadvantages. Interviews and concept maps are the most common ways to elicit possible students' misconceptions. They provide detailed information regarding students' cognitive structures and gain in-depth knowledge about what they think and how they feel about the concepts. However, conducting and analyzing the collected data takes time. Moreover, generalizability is limited (Wandersee et al., 1994).

The traditional multiple-choice test is the preferred tool to detect students' misconceptions because the administration and development process of the multiple-choice test is more straightforward compared to other tools that identify students' misconceptions (Tamir, 1990). But, they have disadvantages. Students may choose the correct answer by chance; that is, all correct students' responses may not reflect a clear understanding of the subject. Furthermore, multiple-choice tests do not allow students to justify their choices or answers. They may choose the correct answer for the wrong reason. This phenomenon is known as a "false positive." Moreover, they may choose the wrong answer for the correct reason, which is known as a "false negative." To be clear, the traditional multiple-choice test cannot provide the discrimination of the correct answers of students due to some factors, such as correct reasoning or wrong reasoning (Hestenes & Halloun, 1995). These problems have prompted researchers to develop two, three, four, and five multi-tier tests to overcome the disadvantages of the traditional multiple-choice test.

Two-tier tests establish superiority over traditional multiple-choice tests. The two-tier tests are comprised of two interconnected questions and are presented like multiple-choice tests. The first-tier consists of content questions with two, three, and four choices and investigates students' misconceptions about the related concept. The second-tier question determines the reason for the answers that students give in the first tier. As such, the second tier includes collections of justifications for the previous tier. These justifications are comprised of correct answers as well as distracters that students' misconceptions of literature (Simpson & Arnold, 1982). When students can't find their reasons among the options, the second tier includes "none of the above" with a blank option where they can write their first-tier



reasoning. Two-tier diagnostic instruments are relatively appropriate to detect students' misconceptions since they help to show the reason behind the students' answers that were chosen in the first tier (Treagust, 1986). Thus, with the help of using two-tier tests, the risk that students can find and guess the answers to questions can be reduced (Adadan & Savasci, 2012).

Based on the literature, two-tier tests were utilized in certain research to identify students' misconceptions about physics (Kanlı, 2015), chemistry (Tüysüz, 2009), and biology concepts (Odom & Barrow, 1995). To assess college biology students' misconceptions about diffusion and osmosis, Odom and Barrow (1995) developed and administered a two-tier test exam. They adapted to the Treagust model while developing the test. There were three general steps in this model, which are "identifying content boundaries tests, collecting information about students' misconceptions of concepts, and developing instruments." At first, they defined the boundaries as diffusion and osmosis, but then they listed 22 propositional knowledge statements about the content with the help of two college biology textbooks and laboratory manuals. Second, to get students' knowledge of diffusion and osmosis, interviews were conducted with 20 students. The interview contained open-ended questions. After the interview, they prepared a 15-item multiple-choice test regarding student interviews and propositional knowledge statements, with free responses. The first tier of the test includes multiple-choice questions with two, three, and four options, while the second tier includes multiple-choice questions that ask why the first tier's answer was correct. Then, the test was applied to 171 non-science primary introductory students who were taught diffusion and osmosis concepts to define misconceptions about the concepts. After that, the face validity of the test was examined, and based on the result, some items were dropped. Finally, the two-tier misconception test with 12 items was administered to 240 students. In this way, the determination of the students' misconceptions about diffusion and osmosis took place.

Tüysüz (2009) conducted a study to develop a two-tier test and determine 9th grade students' misconceptions about the separation of matter. Their methodology was

identical to that of Odom and Barrow (1995), who created the two-tier diagnostic instrument using the Treagust (1987) model. Differently, during the interview, students were asked to make drawings and think about how to load on the particles of the images. Consequently, he created the questions for the two-tier test by using drawings from students.

Some studies critique two-tier tests, despite the fact that they overcome the aforementioned problems of a traditional multiple-choice test. Griffard and Wandersee (2001) assessed the efficiency of a two-tier instrument developed by Haslam and Treagust (1987) in their study on photosynthesis and critiqued the usage of two-tier assessments for discovering students' misconceptions. Six college students participated in the study, and it was expected for students to answer the questions on the two-tier test by thinking loudly. According to the study, using two-tier tests does not give a valid measure of the students' misconceptions. Students may choose the wrong answers, which results from using unnecessary wording. Therefore, it is unclear if the students' incorrect answers were due to misconceptions or unnecessary test wording. What's more, the study showed that students can answer the second-tier question based on whether they logically infer their responses from the first-tier question. Therefore, two-tier tests find students' ability to test-taking skills rather than their current knowledge. Another result of the study shows that two-tier tests exaggerate the rate of misconceptions since the knowledge gap is indistinguishable from two-tier tests. Hence, third-tier questions are required to ensure whether incorrect answers to the first two-tier questions are caused by misconceptions or lack of information.

Three-tier tests provide more advantages in revealing students' misconceptions as they can determine the rate of knowledge with a higher confidence tier. In this way, False positives, false negatives, and a lack of information do not affect the percentages of misconceptions. Each of them needs correction and treatment. Moreover, for the creation of a three-tier misconceptions test, researchers benefit from other diagnostic misconceptions methods, such as interviews and concept maps. For that reason, researchers not only gather students' misconceptions but

develop valid and reliable misconception tests as well. As a consequence, three-tier tests differentiate students' misconceptions or lack of knowledge. Such a situation makes the three-tier test more reliable and valid compared to the aforementioned instruments (Kaltakci-Gurel, et al., 2015). Some studies developed and used three-tier tests to identify student misconceptions in physics (Kutluay, 2005; Pesman & Eryilmaz, 2010), chemistry (Kirbulut & Geban, 2014), and biology (Arslan, Cigdemoglu, & Moseley, 2012).

Kutluay (2005) conducted research and developed three-tier examinations to examine 11th-grade students' misconceptions about geometric optics principles. To create three-tier tests, he benefited from the Tregust (1987) model that was mentioned before. Unlike the Tregust (1987) model, the content boundaries of the study were determined with the aid of literature since there were lots of reviews about geometric optics in the literature. Other procedures for developing tests look like the Tregust (1987) model, including interviews, open-ended analysis, and developing three-tier misconception tests.

Göncü (2013) conducted a study to develop three-tier tests to determine 5th and 7th grade middle school students' misconceptions about astronomy concepts. While developing tests, they benefit from the units' objectives, literature, and interviews, which were done with 5th and 7th grade students. Firstly, they develop traditional multiple-choice questions, including up to 15 questions. Also, there was a space for students to write down the reason for their answers. Secondly, the test was administered to 25 students in the 5th grade and 18 students in the 7th grade. Thirdly, considering students' answers and based on the literature, the second tiers of the test were developed. In the third tier, the question, which included "I'm sure and I'm not sure" options, was added. Four expert opinions were taken. Three of them are field experts, and one of them controlled the test in accordance with grammar. For the pilot study, a total of 43 students were given the tests that had been developed. After the validity and reliability of the tests were checked, they were administered to 5th and 7th grade middle school students. In the present study, most of the questions were taken from this study, and major changes were made to some of them.

On the other hand, in a three-tier misconception test, the confidence tier belongs to both the first tier and the second tier, and this brings about some problems like overestimating the students' scores and underestimating lack of knowledge (Caleon & Subramaniam, 2010a). Accordingly, one more tier is necessary to eliminate the problem and improve the multi-tier test. Four-tier tests complete the three-tier tests. In the four-tier test, the first tier of a test question presents a common multiple-choice question; the second tier includes a question on whether students were confident in answering the first tier; the third tier provides justification of reasons for the answer given in the first tier, and the last tier includes a question asking if students remained confident in their answer after the third tier. This four-tier test can also detect some misconceptions in both responses and reasoning, as well as provide information on confidence levels. With the aid of the four-tier misconception tests, more reliable results can be obtained in determining the level of students' access to scientific knowledge and in detecting misconceptions (Kaltakçı, 2012).

## **2.5 Attitude**

Attitude is a multi-faceted and complex concept (Germann, 1988). Thus, in literature, there are plenty of definitions of the concept of attitude. According to Kruglanski (1989), attitude is "a special type of knowledge, notably knowledge of which content is evaluative or affective" (p. 139), whereas according to Thurstone (1928), attitude is "the total of one's inclinations and feelings, prejudice and bias, preconceived notions, ideas, fears, threats, and convictions about any definite topic" (p. 531). However, for this study, attitude is defined as "a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (Aiken, 2000, p.9). Attitude is made up of three components, which are called the ABC model of attitude. For this model, A refers to the affective dimension, B refers to the behavioural dimension, and C refers to the cognitive dimensions of attitude (Schiffman & Kanuk, 2004). The affective dimension of attitude is a person's emotional or feeling response to a specific object, subject, or topic. Some statements,

such as "I like this" or "I hate this" show the affective part of the attitude. The behavioural dimension of attitude consists of the tendency or disposition of a person to behave in a certain way towards an object or subject (Nelson & Quick, 2012). It requires the (favourable or unfavourable) response of the individual to do something concerning the object of their attitude. The cognitive dimension of an attitude refers to beliefs, thoughts, and qualities that are linked with a subject, an object, or a topic. The statement, "I believe this" shows the cognitive part of the attitude (Jain, 2014).

As it is seen, people express either positive or negative relationships between themselves and objects, so the self-concept is shaped by their attitudes. (Stangor, Jhangiani, & Tarry, 2014). What's more, the dimensions of attitude are not independent of each other. On the contrary, they can have an impact on one another. As a result, when the three components are combined, it is easier to capture all aspects of attitude (Moghaddam, 1998). Based on the literature, there is agreement about the definition of "attitude towards science," and Koballa and Crawley (1985) stated that an attitude toward science is "a positive or negative feeling about science" (p. 223). Many previous studies highlight the importance of attitude in the science of learning (Osborne, et al., 2003; Parker & Gerber, 2000). Parker and Gerber (2000) stated that attitude towards science is essential to the success of science because students' opinions and achievements lead to their career choice. Furthermore, Eccles and Wigfield (2002) noted that students' attitudes influence their willingness to take part in tasks such as implementing the discourse of science. One of the most important goals of every country's national curriculum is to develop positive attitudes towards science (Koballa & Crawley, 1985). There are plenty of studies on attitudes towards science in general. Many of these studies confirm the positive correlation between science achievement and a science attitude. Students with a positive attitude towards science show high participation and performance in science activities (Lee & Burkam, 1996). Wilson (1983) carried out a meta-analysis study to investigate the relationship between science attitude and science achievement. In his study, forty-three separate studies were included. Kindergarteners to university students were among the participants. The findings showed that there was a reliable and positive

correlation between attitudes towards science and science achievement, and also, although the correlation level was low at the elementary level, the correlation level was high in 7th to 11th grade students. Hough and Piper (1982) investigated the associations between students' attitudes toward science and their science achievement with 583 elementary students. The Hough Attitude Inventory was used to examine students' attitudes, while the Hough Pupil Process Test was used to test their science achievement. According to their findings, there was a favourable relationship between science attitude and achievement ( $r = .45$ ). As a result, students who had a favourable attitude toward science performed better in science. Students who had a negative attitude toward science, on the other hand, had low achievement scores. Similarly, Ali, Iqbal, and Akhtar (2013) conducted a study to investigate students' attitudes towards science and the relationship between their attitudes towards science and their achievement scores. The participants included 3,960 intermediate science students who study higher secondary in Pakistan. Data was collected with the aid of the Test of Science-Related Attitude (TOSRA) and their 12th-grade results from a different board. Data were analyzed by using simple correlation, multiple regression, and standardized regression coefficients. According to their findings, there was a favourable and significant association between their science attitude and their achievement score.

Students' grade level can affect students' attitudes towards science. Some researchers have shown that students' attitudes towards science increase as grade level rises (Ilgaz, 2018). In contrast, some studies show that students' attitudes towards science decrease when the grading level increases (Chaerul, 2017; Weinburg, 2000). Additionally, some studies indicate that the classroom learning environment influences students' attitudes towards science (Fraser, Aldridge, & Adolphe, 2003; Lawrenz, 1976). More precisely, traditional science classrooms can cause students to have a negative attitude towards science, whereas a constructivist science classroom enables students to gain a positive attitude towards science. As a result, the teacher should use a constructivist approach to design the learning

environment so that students develop a more positive attitude toward science (Oh & Yager, 2004).

## **2.6 Attitude Towards Astronomy**

Students do not start school by liking or disliking science courses. They can learn to love or hate science lessons at school (Koballa & Crawley, 1985). For that reason, at the beginning of science education, if students are required to have a successful experience and positive emotions, they will gain a positive attitude towards science and be interested. When individuals have bad experiences in science classes, on the other hand, they may desire to avoid science for the rest of their lives and develop a negative attitude towards it (Simpson & Oliver, 1990). Furthermore, taking into consideration not only cognitive characteristics but also affective aspects of students is essential in increasing students' attitudes towards science and increasing their motivation to learn science (Anagün & Duban, 2016). The Turkish Science curriculum, which is currently used, was revised in 2018 in Turkey, and astronomy units start in 3rd grade in the earth and universe subject area. In the revised curriculum, the astronomy units within the earth and universe subject areas are included as the first units of each educational level. This situation shows that units of astronomy have taken on significance.

Since the importance of astronomy education in Turkey has increased, and with this curriculum, students begin their astronomy education early, teachers should strive for students to develop a positive attitude towards astronomy. The development of a positive attitude toward astronomy can also help to popularize other science subjects like chemistry, and biology. As a result, it is believed that individual attitudes towards astronomy may be anticipated and that these attitudes can favourably influence society's attitudes toward science (Tunca, 2002). As such, positive attitudes towards astronomy are considerable, concerning both astronomy and physical science (Wittman, 2009). What's more, the development of positive attitudes towards astronomy is vital for science literacy (Uçar & Demircioğlu, 2011).

According to the literature, few researchers have examined the attitudes toward astronomy of middle school students, university students, and preservice teachers from diverse age groups and countries. Nilsen and Angell (2014) conducted a study with 232 8th grade students to investigate how astronomy attitudes, astronomy discourse practice, and conceptual comprehension of astronomy concepts influence the learning process and lead to good performance. The data was collected using both questionnaires (n = 200) and interviews (n = 32). Participating students have a positive attitude toward astronomy, as demonstrated by questionnaires and interviews. Furthermore, their studies revealed that their attitude toward astronomy had a substantial impact on the success of astronomy.

Türk and Demir (2016) conducted a study to examine the differences in attitudes towards astronomy for all grades. The sample was included 205 prospective pre-school teachers (1st, 2nd, 3rd, and 4th grade) studying in the education faculty of a university in the Eastern Anatolia region of Turkey. Data was collected by using an instrument on the Astronomy Attitude Scale (AAS). The one-way ANOVA was performed to see whether preservice pre-school teachers' attitudes towards astronomy differed based on their grades. According to their findings, their attitudes toward astronomy were not affected by their grades. In addition, prospective teachers' ratings of attitudes towards astronomy ranged from 3.42 to 3.48, indicating that they have an "undecided" attitude towards astronomy. The same result was found in the study, which was conducted by Okulu and Unver (2011) to determine the preservice teachers' attitude towards astronomy. The sample consists of three different teaching programs, which are preservice science teachers (n = 90), classroom teachers (n = 52), and social studies teachers (n = 51). As a data gathering tool, a "Survey of Attitude Toward Astronomy" was used. According to the findings, preservice science teachers' attitudes towards astronomy scores were 3.31, preservice classroom teachers' scores were 3.12, and preservice social studies teachers' scores were 3.17. As such, the preservice teacher's attitude towards astronomy is undecided at this level.



There are a few studies that examine the relationships between misconceptions about astronomy concepts and attitudes towards astronomy. Bektaslı (2016) investigated the relationship between astronomy misconceptions and attitudes toward astronomy in a study with 78 preservice teachers. During the previous semester, the subject took a two-credit astronomy class. To collect data, astronomy misconceptions and an astronomy attitude test were used. In addition, three students with low, medium, and high attitudes were interviewed to allow them to fully explain their conceptual test responses. The study found that students with a medium or high attitude toward astronomy had a better understanding of the subject than students with a low attitude. Bektaslı (2013) did a second study with 82 preservice science instructors to see whether the media has an impact on both astronomy attitudes and achievement. In this experiment, two groups were not chosen at random but rather based on the last name's alphabetic order. While the lectures in the control group were presented using standard techniques, the lectures in the experimental group were covered utilizing media that were relevant to astronomical ideas. Two groups were given a pre-post-test. Data was gathered through a survey of astronomy attitudes as well as astronomy concept tests. The preservice teacher had a lack of understanding and misconceptions about astronomy at the start of the course.

## **2.7 Gender Differences in terms of Misconceptions about Astronomy Concepts and Attitudes Towards Astronomy**

Some factors, such as gender, grade level, and the classroom learning environment, influence students' attitudes towards science (Ali, Yager, Hacıeminoglu, & Caliskan, 2013). Gender is one of the significant factors affecting attitudes towards science (Osborne, et al., 2003). Gardner (1975) also pointed out that "*sex is probably the most significant variable related to students' attitudes towards science*" (p. 22). Based on the literature, there are some conflicting results related to the disparity between genders in attitudes towards science. According to some studies, there is no difference in attitudes toward science between males and

females (Çokadar & Külçe, 2008; Sofiani, Maulida, Fadhillah, & Sihite, 2017). On the other hand, many kinds of research show that male students have a more positive attitude toward science than female students (Greenfield, 1996; Simpson & Oliver, 1985). As opposed to the aforementioned suggestion, some studies found that females had a more positive attitude towards science than males (Mihladız, Duran, & Doğan, 2011; White, 1999). For instance, Mihladız, Duran, and Doğan (2011) aimed to determine the relationship between 6th, 7th, and 8th grade students' attitudes towards science and gender, grade level, and family income level. They studied with 882 students and used a survey model for their study. Data was collected through the Science Attitude Scale. The study revealed that female students have more positive attitudes toward science than male students. In contrast to the study, Weinberg (1995) reported that male students had a more positive attitude towards science than female students. This meta-analysis study, it was sought to examine gender differences in students' attitudes towards science and their achievement in science. There was a total of 6753 students, 3337 of whom were males, and 2416 were females. He examined eighteen studies that were done between 1970 and 1991. Some studies did not find a difference between female and male students. For the sake of example, Sofiani, Maulida, Fadhillah, and Sihite (2017) conducted a study with 77 tenth grade students to investigate the effect of gender on attitudes towards science. The data was provided using a 23-item attitude questionnaire with four dimensions: enjoyment, self-confidence, value, and motivation. The result showed that there was no noticeable difference between the genders of the students. The disparities between males and females can be related to stereotypes about scientists and science. Both males and females probably see science as a product of male-dominated education and also as a male occupation. Apart from this, the most common sociological explanations for females' fewer positive attitudes towards science than males are different cultural expectations provided by parents, teachers, and peers, as well as different science experiences at school and in private life (She, 1998).

Specifically, Dewitt and Bultitude (2018) did a study to investigate students' attitudes towards astronomy and their perceptions of astronomy careers. The number of participants was about 8000 students aged between 9 and 16 across 11 European countries. According to the results, males had more positive attitudes towards astronomy than females in northern European countries, whereas gender differences may be less significant in eastern European countries. In addition to the studies that showed a significant difference in attitude towards science between genders, Marusic and Hadzibegovic (2018) did a study to compare 16-18-year-old students' attitudes towards astronomy in Bosnia Herzegovina and Croatia by using a self-reported questionnaire. The participants were 396 high school students. The findings of the survey revealed that there was no significant difference in attitudes toward astronomy between male and female participants.

Yeşil and Benzer (2020) carried out a study to show the effect of education level and gender variables on pre-service science teachers' attitudes towards astronomy. The research was conducted with 78 pre-service science teachers and the "Astronomy Attitude Scale", which was created by Zeilik, Schau, and Mattern (1999) and adapted to Turkish by Canbazoğlu-Bilici, Öner-Armağan, Kozcu- Çakır, and Yürük (2012), was used. The study's findings found that there was no significant difference in attitudes towards astronomy between male and female participants.

Gali and Venukapalli (2021) researched to see how spatial ability affects secondary school students' conceptual understanding of astronomy concepts. A total of 38 9th grade students took part in the study. To collect data, astronomical topic tests, Purdue Spatial Visualization Test: Visualization of Rotations, mental rotation tests, and spatial reasoning tests were used. According to the study, gender did not affect students' correct responses to astronomy concepts.

## **2.8 Interest in Astronomy in terms of Misconceptions about Astronomy Concepts and Attitudes Towards Astronomy**

Intrinsic motivation is beneficial to learning (Deci & Ryan, 1985). Students are more likely to participate in learning activities when they have an innate desire to learn about the topics. Intrinsic motivation requires a high level of interest (Krapp, 2002). Intrinsic motivation is aided by interest, which stimulates the initiation and direction of attention as well as exploratory activity (Reeve, 1989). According to Wade (2001), interest in science topics was defined as "specific and relatively stable" (p.245). Additionally, "it develops over time and is associated with personal significance, positive emotions, high value, and increased knowledge." (p.245). Interest and learning mutually reinforce each other's (Lavin, 1965). People's interests in science are vital for learning science, and the most essential aspect of learning science is students' attitudes. Attitudes towards science could boost students' interest in science. A positive attitude can help students understand more about scientific subjects both formally and informally (George, 2006). Similarly, Simpson and Oliver (1990) pointed out that a positive attitude toward science "leads to a positive commitment to science that influences lifelong interest and learning in science." (p. 14).

Ogunkola and Fayombo (2009) did a study to examine the relationships between students' performance and gender, school location, interest in science, study habits, future career choice, and the relative effects of the five variables on students' science achievement. The participants consisted of 300 students whose ages were between 13 and 15. The instruments, which were the Science Achievement Test (SAT), the Interest in Science Scale (ISS), and the Study Habit Scale (SAS), were used to collect data. The result showed that there was a considerable difference between students' science achievement and a high interest in science, good study habits, and pursuing a career in science.

Buxner, Impey, Romine, and Nieberding (2018) conducted a study to investigate the link between introductory astronomy students' knowledge, beliefs, and science

literacy. The participants included 43 625 students, among whom were 34 072 undergraduates, among whom were 7946 graduates. Data was collected with the aid of the Science Knowledge, Attitudes, and Beliefs Survey and Interest and Sources of Information in Science. Data was gathered through two student surveys between the years 1989 and 2016. The research revealed that when students were more interested in science, they performed better on questions about scientific knowledge.

## **2.9 Future Occupation in terms of Misconceptions about Astronomy Concepts and Attitudes Towards Astronomy**

One of the main objectives of the Turkish science curriculum is for students to gain a better grasp of scientific careers and entrepreneurial applications (MONE, 2018). Keeping this in mind, identifying, training, and equipping students for their future careers is one of the key purposes of relevant science education. Students can evaluate a variety of variables while deciding on a career path or career choice. Some factors, such as school experiences, achievement abilities, and interests in science, may determine students' future occupations (Sadler, et al., 2012). Also, socioeconomic status (SES) and achievement affect students' career aspirations (Ashby & Schoon, 2010). To illustrate, Areepattamannil, Cairns, and Dickson (2020) investigated the relationships between stem career goals and science achievement, as well as students' enjoyment of science, science self-efficacy, interest in science, and motivation. The data was derived from the PISA 2005 database. The sample consisted of 5158 students aged 15 years old. The study underlined that there was a significant association between science achievement and STEM career aspirations, with male students having a much larger association. According to the study, STEM career aspirations were found to be significantly positively connected with students' enjoyment of science, science self-efficacy, excitement for science, and instrumental motivation to learn science, not only for females but also for males, according to the study. Correspondingly, Karakaya, Avgın, and Yılmaz (2018) conducted a study to

investigate middle school students' interests in Science, Technology, Engineering, and Mathematics (STEM) careers based on a variety of factors. The participants consisted of 611 middle school students. The study showed that there was a significant difference between their interest in STEM professions and their level of academic achievement. In detail, it was discovered that students who received a certificate of appreciation had a higher degree of interest in science, technology, engineering, and mathematics professions than students who received a certificate of appreciation but no certificate.

## **2.10 Summary of Literature Review**

Constructivism as a theory depends on the learner's contact with real-world experiences, previous knowledge, mental structures, knowledge-construction beliefs, and meaningful contexts (Jonassen, 1991). Constructivism has two distinct characteristics. The first is eliciting prior knowledge from students. According to Ausubel (1968), prior knowledge is the most important component in determining to learn, and meaningful learning occurs when students relate newly learned concepts to their existing knowledge. The second is creating cognitive conflict that obstructs students' misconceptions by establishing equilibrium between previously taught and newly acquired knowledge (VandenBerg & Grelle, 2009). The constructivist learning approach has been used in Turkey's scientific curriculum since 2005 (MONE, 2005).

Any firmly held idea that contradicts generally accepted scientific concepts is regarded as a misconception (Comins, 2001, p.56). According to research, textbooks, teachers' language, family members, the students' peer group, cultural beliefs, the media, socioeconomic factors, and students' personal beliefs can all contribute to the establishment of misconceptions (Patil, Chavan, & Khandagale, 2019). Numerous studies in the literature deal with misconceptions about physical, biological, and chemical phenomena. Many studies have been undertaken in the literature to determine specific student misconceptions about astronomy concepts. Common

misconceptions are about the phases of the Moon, the Earth, seasons, and meteor showers.

Students' misconceptions must be identified for them to understand topics and learn in a meaningful way. As such, identifying misconceptions is the first step to addressing them (Carle, 1993). There are various types of diagnostic tools that have been developed and used to measure students' misconceptions. These tools include interviews, concept maps, open-ended questions, multiple-choice tests, and multi-tier tests that include two-tiers, three-tiers, or four-tiers. All tools have advantages as well as disadvantages. Multiple-choice assessments, for example, do not allow students to justify their answers or choices. They may choose the correct answer for the wrong reason, but the multiple-choice test's administration and development are simple and therefore common (Tamir, 1990). Considering the advantages and disadvantages of all these diagnostic tools, the four-tier test is considered the most suitable among them since it is simple to administer to students and provides more reliable results in determining students' access to scientific information and recognizing misconceptions (Kaltakçı, 2012). For that reason, in the present study, MTAC was developed and applied.

According to Aiken (2000), attitude is defined as "a learned predisposition to respond positively or negatively to a specific object, situation, institution, or person" (p.9). Based on the literature, there is a consensus about the definition of "attitude towards science," and according to Koballa and Crawley (1985), an attitude toward science is "a positive or negative feeling about science" (p. 223). Many previous studies highlight the importance of attitude in the science of learning (Osborne, et al., 2003; Parker & Gerber, 2000). According to Parker and Gerber (2000), students' attitudes toward science are critical to their success since their ideas and achievements influence their career choices. The majority of the studies show that there is a link between scientific achievement and a good attitude toward science. For example, Wilson (1983) undertook a meta-analysis study to investigate the relationship between attitudes towards science and science achievement. The participants ranged from kindergarteners to undergraduate students. He found that there was a positive

correlation between attitudes towards science and science achievement. Hence, students' grade level and the classroom learning environment can affect their attitudes towards science.

Since the importance of astronomy education in Turkey has increased, and with revised curriculum, students begin their astronomy education early, teachers should enable students to develop a positive attitude towards astronomy. Developing a positive attitude towards astronomy can also play an active role in developing similar attitudes towards physics, chemistry, and biology. It is, therefore, thought that the attitudes of individuals towards astronomy can affect the attitudes of society at large towards science (Tunca, 2002). The literature on this topic provides limited research articles that measure the attitudes towards astronomy of middle school students, university students, and prospective teachers from different age groups and cultures. (Nilsen & Angell, 2014; Türk & Demir, 2016). For example, Nilsen and Angell (2014) conducted a study to investigate how that affects the process of learning and if it leads to high performance by focusing on the influence of astronomy attitude, astronomy discourse practice, and understanding of astronomy concepts. Participants included 232 8th grade students. Results show that most students have a positive attitude towards astronomy. This general attitude towards astronomy had a significant effect on their success in studying astronomy. It also highlighted that students with a positive attitude towards astronomy can stimulate their learning and study more diligently in other subjects.

Gender is a significant factor affecting attitudes towards science (Osborne, et al., 2003). According to numerous studies, male students have a more positive attitude towards science than female students (Greenfield, 1996; Simpson & Oliver, 1985). Contrary to the aforementioned suggestion, some studies have indicated that females have a more positive attitude toward science than males (Mihladiz, et al., 2011; White, 1999). Moreover, people's interests in science are critical for learning science, and students' attitudes are one of the most essential aspects of learning science. According to the findings of certain studies, academic achievement is influenced by a person's interests (Jansen, Lüdtke, & Schroeders, 2016; Scholastica, 2020) and



conceptual change (Windschitl, 2003; Ogunkola & Fayombo, 2009). For example, Ogunkola and Fayombo (2009) conducted research into the relationships between student performance and gender, school location, science interest, study habits, and future occupation aspirations, and the relative influence of these five variables on students' science achievement. The participants included 300 students whose ages were between 13 and 15. According to their results, there was a significant correlation between students' science achievement and a high interest in science, good study habits, and a desire to pursue a career in science. In addition, one of the key goals of the Turkish science curriculum is to increase students' understanding of scientific careers and entrepreneurial applications in science (MONE, 2018). Students who engaged in astronomy-related educational activities in elementary or secondary school are more likely to continue science and technology careers and participate in scientific research (NRC, 1991). Areepattamannil et al. (2020) investigated the relationships between STEM career aspirations and science achievement, as well as students' enjoyment of science, science self-efficacy, interest in science, and motivation. A total of 5158 students aged 15 took part in the study. They claimed that academic achievement and a willingness to pursue a STEM career were linked. STEM career aspirations were found to be associated with female and male students' enjoyment of science, science self-efficacy, excitement for science, and willingness to learn science.



## CHAPTER 3

### METHOD

#### 3.1 Research Design

In this study, 6th and 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards science were investigated. Moreover, the relationships between students' misconceptions about astronomy concepts and their attitudes towards science and differences in grade level, gender interest in astronomy, and future occupation. For this purpose, both correlational and causal-comparative research approaches were used in the study. According to Fraenkel and Wallen (2009), the goal of correlational research is to determine the relationship between two or more variables, as well as their cause and effect. In this study, correlational research was used in the determination of the relationship between students' misconceptions about astronomy concepts and their attitudes towards science. Furthermore, a causal-comparative research approach was used to investigate disparities in gender, interest in learning astronomy, and future occupations for 6th and 7th grade students. This study model allows researchers to compare and contrast groups (Fraenkel & Wallen, 2009).

#### 3.2 Participants

The sample was selected from the population by using cluster random sampling. The study's accessible population consisted of 60 public schools located in Ankara and the Çankaya district. Of these schools, six schools were chosen at random. The sample of this study included 708 middle school students (360 students were in 6th grade and 348 were in 7th grade). There were 396 females and 312 males among the students. Table 3.1 illustrates the demographic information of the participants. In

general, students preferred to learn about science subjects from textbooks rather than other books. The vast majority of 6th and 7th grade students were interested in astronomy, yet the vast majority of people students did not engage in any astronomy-related activities. In terms of future occupations, students' open responses were categorized according to their chosen occupations as math, science, and social sciences. To explain, if students chose an occupation related to math and science, the student's answer was categorized as 1. Also, if they choose an occupation related to the social sciences, it is categorized as 0. As a result, while 55.2% of students wanted to pursue occupations in math and science, only 41.5% of students wanted to pursue occupations in social science.

Table 3-1 Demographic Information of Participants

| Variables   |                    | 6   |      | 7   |      | Total |      |
|---|--------------------|-----|------|-----|------|-------|------|
|   |                    | n   | %    | n   | %    | n     | %    |
| Gender  | Male               | 179 | 49,7 | 133 | 38,2 | 312   | 44,1 |
|   | Female             | 181 | 50,3 | 215 | 61,8 | 396   | 55,9 |
| Sources to follow science subjects                        | School Books       | 263 | 73,1 | 266 | 76,4 | 529   | 74,7 |
|   | Magazines          | 32  | 8,9  | 18  | 5,2  | 50    | 7,1  |
|   | Other Books        | 15  | 4,2  | 11  | 3,2  | 26    | 3,7  |
|   | Internet Resources | 50  | 13,9 | 53  | 15,2 | 103   | 14,5 |
| Interest in Astronomy                                     | No                 | 48  | 13,3 | 38  | 10,9 | 86    | 12,1 |
|   | Yes                | 312 | 86,7 | 310 | 89,1 | 622   | 87,9 |
| Participating in events related to Astronomy and the Sky. | No                 | 309 | 85,8 | 277 | 79,6 | 586   | 82,8 |
|   | Yes                | 51  | 14,2 | 71  | 20,4 | 122   | 17,2 |
| Future occupation   | Math and Science   | 207 | 57,5 | 184 | 52,9 | 391   | 55,2 |
|   | Social Science     | 142 | 39,4 | 152 | 43,7 | 294   | 41,5 |
|   | Undecided          | 11  | 3,1  | 12  | 3,4  | 23    | 3,2  |

### 3.3 Instrumentation

Three instruments were used to collect data: demographics questionnaire (Appendix A), astronomy attitude scale (AAS) (Appendix B), and Misconceptions Test About Astronomy Concepts (MTAC), (Appendix C).

#### 3.3.1 Astronomy Attitude Scale (AAS)

The Astronomy Attitude Scale (AAS) was developed by Kalkan and Türk (2015) to assess middle school students' attitudes towards astronomy. The AAS a likert scale with a total of 27 items. The items on the scale are ranked from 1 through 5, with 1 representing total disagreement and 5 representing total agreement. The scale contains the following sub-factors: liking (items 1 and 2), self-confidence (items 3,16,17,18), being interested (items 4,5,6,7,11,12), application (items 8,9,10,13,14), and daily life (items 15,19,20,21,22,23,24,25,26,27). The overall scale's Cronbach's alpha of reliability was obtained 0.912. The sub-factors of Cronbach's alpha coefficients were calculated as shown in Table 3.2.

Table 3-2 The values of Cronbach's Alpha coefficients of AAS sub-factor

| Sub-factors      | Reliability coefficient | Item numbers |
|------------------|-------------------------|--------------|
| Liking           | 0,875                   | 2            |
| Self confidence  | 0,869                   | 4            |
| Being interested | 0,786                   | 6            |
| Application      | 0,721                   | 5            |
| Daily life       | 0,715                   | 10           |

*Pilot Study for Attitude Astronomy Scale*

After taking permission from the researcher (Appendix D), a pilot study was carried out to validate the AAS's validity and compute Cronbach's alpha. The pilot project included 201 Ankaya/Çankara middle school students (72 in 5th grade, 66 in 6th grade, and 63 in 7th grade). For this study, confirmatory factor analysis (CFA) was done to ensure the validity of the scale. The proposed CFA model was subjected to path analysis using IBM AMOS 21. The following goodness-of-fit indices were discovered for this study: The Chi-Square goodness index, the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), the normed fit index (NFI), the root mean square residuals (RMR or RMS), and the root mean square error of approximation (RMSEA)]. Light of the findings of the CFA, as shown Table 3.3, it was determined that the calculated indices of  $\chi^2 / sd$  and RMSEA give acceptable fit indices, while GFI, AGFI, CFI, and RMR fit indices are close to and provide acceptable fit indices.

Table 3-3 Astronomy Attitude Scale CFA Analysis Calculated Fit Indices and Roadmap

| Acceptable Fit Indices        | Calculated Fit Indices |
|-------------------------------|------------------------|
| $\chi^2/sd < 5$               | 1,722                  |
| GFI $\geq .90^b$              | 0,836                  |
| AGFI $\geq .90^b$             | 0,803                  |
| CFI $\geq .90^{a,b}$          | 0,870                  |
| RMSEA $\leq .05^b$ to $.10^a$ | 0,060                  |
| RMR $\leq .08^c$ to $.10^d$   | 0,099                  |

Reference: <sup>a</sup> Tabachnick & Fidell (2007), <sup>b</sup> Sumer (2000), <sup>c</sup> Hu & Bentler (1999),  
<sup>d</sup> Kline (2011)

The Astronomy Attitude Scale (AAS) was used in this study to measure the attitudes of 6th and 7th grade middle school students toward astronomy. Confirmatory factor

analysis (CFA) was utilized to examine the scale's factor structure. According to the findings, five of the same sub-factors were discovered, as shown in Table 3.4. Also, as given in Table 3.4 Cronbach alpha reliabilities were calculated. The values were all within an acceptable range for a scale addressing the participants' affective domain.

Table 3-4 The values of Cronbach's Alpha Coefficients of AAS sub-factor

| Sub-factor       | Reliability coefficient | Item numbers |
|------------------|-------------------------|--------------|
| Liking           | ,788                    | 2            |
| Self confidence  | ,634                    | 4            |
| Being interested | ,669                    | 6            |
| Application      | ,709                    | 5            |
| Daily life       | ,839                    | 10           |

### 3.3.2 Misconception Test about Astronomy Concepts (MTAC)

The Misconceptions Test About Astronomy Concepts (MTAC) was developed to measure students' misconceptions about astronomy concepts. Misconceptions about astronomy concepts were measured both in terms of misconceptions and correct responses about astronomy concepts. The researchers undertook a comprehensive literature review in order to develop MTAC. Diagnostic tools developed by earlier studies at the national and international levels were also examined. All of the students' misconceptions about astronomy concepts from the studies were compiled. These misconceptions were given in Chapter 2. Based on these misconceptions and objectives covered in the science curriculum, a table of the specification was developed (Table 3.5). The questions were then prepared to address each cell included in the table of specifications. Generally, for each misconception, more than one question was developed. The questions were either adopted from earlier studies or newly developed for this study. Both 6th and 7th grade students know the astronomy concepts of the structure of the Sun, the features of the planets, the Moon,

the phases of the Moon, lunar and solar eclipses, and meteors. For that reason, MTAC was created under these concepts.

Table 3-5 Table of Specification

| OBJECTIVES                                     |  |   |   |   |   |   |
|--|--|---|---|---|---|---|
| SUBJECTS                                       | Explains the characteristics of the Sun. | Explains the revolution and rotation of the Moon. | Explains the relationship between the phases of the Moon and the movement of the Moon around the Earth. | Explains basic properties of planets (terrestrial, gaseous, inner planet, outer planet) | Explain, meteor, meteorite, asteroid concepts | It is mentioned that there is no solar eclipse every month.<br>Every month, it is mentioned that there is no lunar eclipse. |
| 5.1.1. The Structure and Properties of the Sun | Q1, Q2                                   |   |   |   |   |   |
| 5.1.3. Movements and Phases of the Moon        |  | Q4, Q5  | Q6  |   |   |   |
| 6.1.1 Solar System                             |  |   |   | Q3, Q10   | Q8, Q9  | Q7  |

*Pilot study for Misconceptions About Astronomy Test (MTAC)*

As mentioned earlier, Göncü (2013) developed three-tier astronomy misconception tests for her study. These tests consist of 15 questions for both 5th grade and 7th grade middle school students, which were suitable for the curriculum of that time.



Also, one question developed by Küçüközer (2007) was used in this current study. For the present study, after taking permission from the researchers (Appendix E) and (Appendix F), questions were selected from these tests according to the current curriculum. Three-tier astronomy misconception tests were created. To be clear, 9 questions were chosen for 5th grade, 9 questions were included for 6th grade from 5th grade tests, and 8 questions were added according to the 6th grade curriculum. In these tests, each question measures a misconception. These tests were conducted to a total of 120 students, 60 of whom were in the fifth and sixth grades, and took part in this pilot study. Table 3.6 shows the 5th grade students' misconceptions about astronomy concepts.

Table 3-6 Three -Tier Misconception Scores of 5th Grade Students

|                               | <b><u>Proportions of misconception values for each question</u></b> |                  |                  |                  |                  |                  |                  |                  |                  |
|-------------------------------|---|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                               | <b><u>Q1</u></b>  | <b><u>Q2</u></b> | <b><u>Q3</u></b> | <b><u>Q4</u></b> | <b><u>Q5</u></b> | <b><u>Q6</u></b> | <b><u>Q7</u></b> | <b><u>Q8</u></b> | <b><u>Q9</u></b> |
| <b>All Four Tiers</b>         | 0%  | 0%               | 8%               | 8%               | 3%               | 3%               | 10%              | 5%               | 8%               |
| <b>First and Second tiers</b> | 0%  | 0%               | 10%              | 8%               | 3%               | 8%               | 18%              | 8%               | 20%              |
| <b>Only First Tiers</b>       | 0%  | 3 %              | 10%              | 10%              | 5%               | 8%               | 18%              | 10%              | 30%              |

According to table 3.6, only question six was significant because, according to Caleon and Subramaniam (2010a), misconceptions are considered significant for the proportions of at least 10% of the sample. This is a misconception: The phases of the Moon emerge when the Moon enters the Earth's shadow.

Table 3-7 Three -Tier Misconception Scores of 6th Grade Students

|                               | <b>Proportions of misconception values for each question</b> |           |           |           |           |           |           |           |           |            |            |            |            |            |            |            |            |
|-------------------------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|
|                               | <u>Q1</u>  | <u>Q2</u> | <u>Q3</u> | <u>Q4</u> | <u>Q5</u> | <u>Q6</u> | <u>Q7</u> | <u>Q8</u> | <u>Q9</u> | <u>Q10</u> | <u>Q11</u> | <u>Q12</u> | <u>Q13</u> | <u>Q14</u> | <u>Q15</u> | <u>Q16</u> | <u>Q17</u> |
| <b>All Four Tiers</b>         | 0 %  | 3 %       | 0 %       | 3 %       | 3 %       | 8 %       | 3 %       | 5 %       | 20 %      | 13 %       | 13 %       | 13 %       | 3 %        | 13 %       | 18 %       | 10 %       | 10 %       |
| <b>First and Second tiers</b> | 0 %  | 3 %       | 0 %       | 5 %       | 10 %      | 18 %      | 5 %       | 10 %      | 33 %      | 18 %       | 20 %       | 20 %       | 8 %        | 28 %       | 35 %       | 18 %       | 13 %       |
| <b>Only First Tiers</b>       | 0 %  | 8 %       | 3 %       | 5 %       | 12 %      | 20 %      | 18 %      | 12 %      | 43 %      | 19 %       | 22 %       | 32 %       | 10 %       | 30 %       | 37 %       | 20 %       | 15 %       |

Table 3.7 shows the 6th grade students' misconceptions about astronomy concepts. Questions 9, 10, 11, 12, 14,15, 16 and 17 are questions that show the significant misconceptions about astronomy concepts. In a three-tier misconception test, the confidence tier belongs to both the first tier and the second tier, and this brings about some problems like overestimating the students' scores and underestimating lack of knowledge (Caleon & Subramaniam, 2010a). Also, misconceptions should be measured with many questions in varied contexts to reduce the noise of false-positive scores (Peşman and Eryılmaz, 2010). Taking all of this into account, the tests utilized in the pilot study were altered, and a new test was developed. To be explicit, the newly developed test is a four-tier misconception test, and all of the new curriculum's misconceptions were attempted to be measured with at least three questions.

According to Table 3.8, except for questions 3 and 10, these questions were taken from other previous studies with some changes, considering the science curriculum used. Concepts covered in the test included the features of the planet, the structure of the Sun, the rotation of the Moon, the phases of the Moon, eclipses, and meteor showers. Table 3.8 below presents all the questions used for MTAC. Most of the questions were taken from Göncü (2013). They developed three-tier misconception tests, and hence the fourth tier was added to all the questions received from their studies; that is, the three-tier misconception test includes one confidence level, and

the four-tier tests contain two confidence levels that ask students if they are sure about the first and third tiers. In addition, many of the alternatives to their tests have been modified according to the misconceptions identified for this study. Furthermore, since there are no four-tier questions about planets in the literature, two four-tier questions about planets were developed by researchers.

Table 3-8 Questions of Misconception Test about Astronomy Concepts

| QUESTION   | Sources                    | How to change   |
|--|----------------------------|---|
| 1. Misconception related to sun.   | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 2. Misconception related to sun.<br>Misconception related to the meteor.                       | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 3. Misconception related to sun.<br>Misconception related to planet.                           | Constructed by researchers |   |
| 4. Misconception related rotation of the moon.   | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 5. Misconception related rotation of the moon.   | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 6. Misconception related to phases of the moon.<br>Misconception related rotation of the moon. | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 7. Misconception related to the eclipses.<br>Misconception related rotation of the moon.       | <b>(Küçüközer, 2007)</b>   | This question, which was created with a multiple-choice test, was changed to a four-tier question.  |
| 8. Misconception related to the meteor.  | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |
| 9. Misconception related to the meteor.  | <b>(Göncü, 2013)</b>       | This question, which was originally created as a three-tier, was changed to a four-tier question. In addition, most of the question options were changed based on the new curriculum. |

|                                     |                            |  |
|-------------------------------------|----------------------------|--|
| 10.Misconception related to planet. | Constructed by researchers |  |
|-------------------------------------|----------------------------|--|

\*New curriculum was accepted in 2018 in Turkey.

### **Validity and Reliability of MTAC**

The validity of test scores was evaluated using both qualitative and quantitative methods. Content validity was established by using expert opinions. Expert opinions were taken from three professors in science education, one astronomer, three science teachers, and two middle school students. Additionally, one Turkish language teacher checked the questions in the test for proper language usage. Based on the comments provided by the experts, the questions were revised.

For construct validity, two quantitative procedures were employed to determine test score validity. One of the procedures was analyzing correlations between students' scores on the first, reasoning, and confidence tiers, and the other one was assessing the percentages of false negatives and false positives. According to Çataloğlu (2002), for construct validity, there should be a positive correlation between students' test scores and their confidence levels; that is, students with high test scores are more likely to feel confident in the accuracy of their responses, assuming they comprehend what they read on the exam accurately. Three different correlations were created for this purpose. These relationships are shown in Table 3.9 for all three combinations.

Table 3-9 Correlations between Scores

|                               |                     | First Confidence Score  |
|-------------------------------|---------------------|-------------------------|
| Correct Only First Score      | Pearson Correlation | .373**                  |
|                               | Sig. (2-tailed)     | .000                    |
|                               | N                   | 708                     |
|                               |                     | Second Confidence Score |
| Correct Only Third Score      | Pearson Correlation | .299**                  |
|                               | Sig. (2-tailed)     | .000                    |
|                               | N                   | 708                     |
|                               |                     | Both Confidences Score  |
| Correct First and Third Score | Pearson Correlation | .393**                  |
|                               | Sig. (2-tailed)     | .000                    |
|                               | N                   | 708                     |

According to Cohen (1988, pp 79-81), magnitude of correlations can be interpreted with criteria given below:

If  $r = 0.10$  to  $0.29$  or  $-0.10$  to  $-0.29$ , there is small correlation

If  $r = 0.30$  to  $0.49$  or  $-0.30$  to  $-0.49$ , there is medium correlation

If  $r = 0.50$  to  $1.00$  or  $-0.50$  to  $-1.00$ , there is large correlation

As a result, this research revealed small, medium, and significant correlations between the correct first score and the first confidence score ( $r = .373$ ), the correct first and third score and both confidence scores ( $r = .299$ ), and the correct first and third score and both confidence scores ( $r = .393$ ). This result shows that students with high scores had more confidence than students with low scores. The scatter plots for the correct only first score and first confidence score, the correct only third score and second confidence score, and the correct first and third score and both confidence values are shown in Figure 3.1. Despite the low scores, when the scatter plots were reviewed, some students expressed confidence in their responses. Their incorrect answers could be due to misconceptions or a random choice of the incorrect answer.

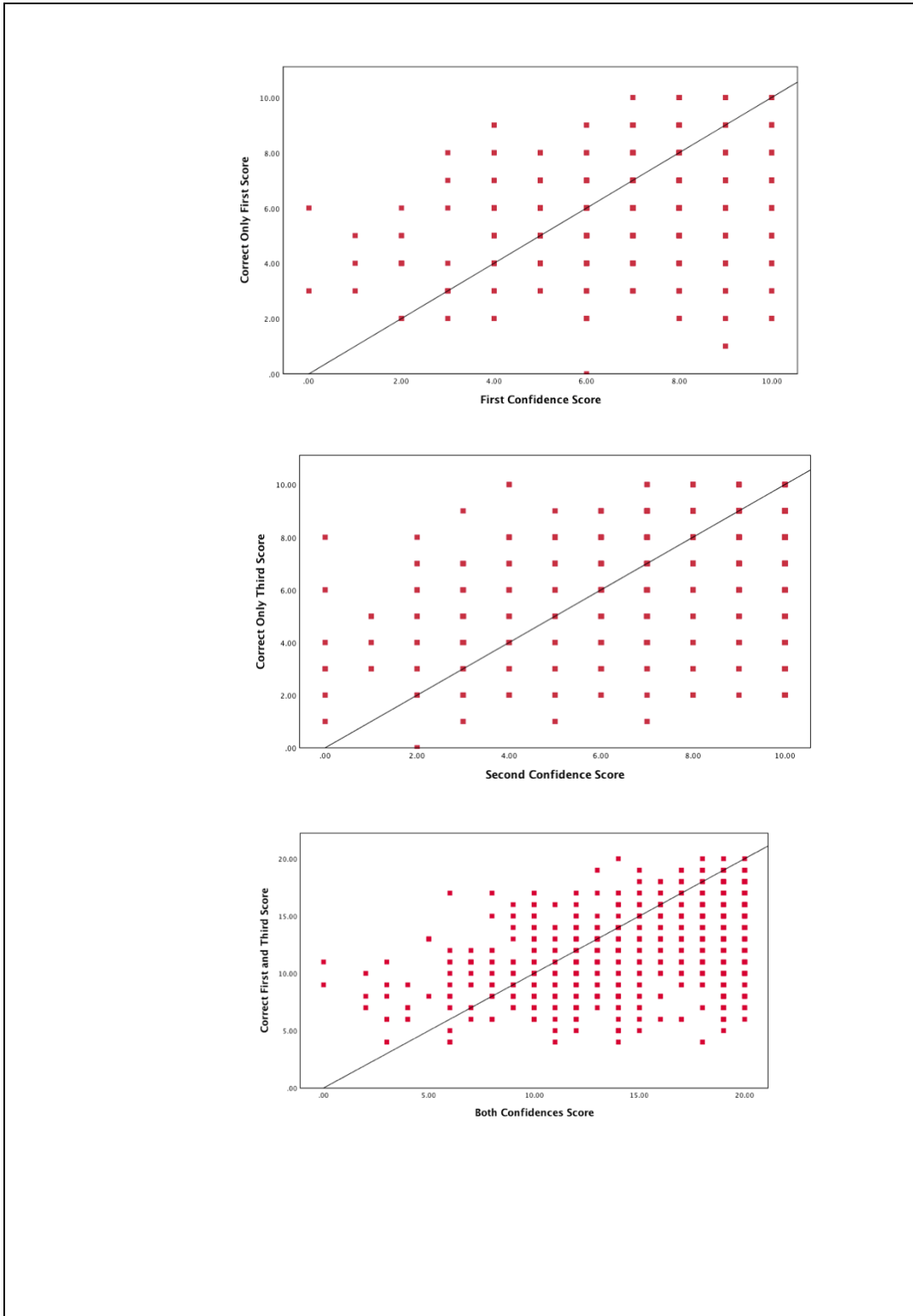


Figure 3.1 Scatter Plots of Scores

According to Hestenes and Halloun (1995), the correct answer with incorrect scientific thinking is called a "false positive," whereas the incorrect answer with correct scientific thinking is called a "false negative." As a result, they advocated the use of a more valid test that would eliminate false negatives and positives, and they stated that false negative and false positive scores should be estimated in order to ascertain the accuracy of the test. According to them, the proportions of the false negative and false positive scores should be below 10% to validate content validity. In this study, the proportion of false-positive and false-negative scores for 6th grade students were found to be 9.7% and 8.2%, respectively, while the proportion of false-positive and false negatives for the 7th grade was found to be 8.1% and 7.5%, respectively.

### **Reliability of MTAC**

For 6th grade students, the Cronbach alpha for misconception scores was 0.43, and for 7th grade students, it was 0.47. The Cronbach alpha for correct responses to astronomy concepts scores was determined to be 0.64 for 6th grade students and 0.68 for 7th grade students. As mentioned before, most of the questions were taken from Göncü (2013). They prepared two misconception tests related to misconceptions about astronomy concepts for 5th grade and 7th grade. The KR-21 reliability of the test for misconception scores for 5th grade students was found to be 0.70. It was found to be 0.75 for 7th grade students. In terms of achievement scores, they were found to be 0.54 for 5th graders and 0.57 for 7th graders. These results are similar to the results found in the new study.

### **3.4 Data Collection Procedure**

Due to the COVID-19 pandemic, the data was collected with the help of Google Form during the fall semester of the 2020-2021 academic year. Before starting data collection, necessary permissions were obtained from the ethics committee of the Middle East Technical University (Appendix F) and the Ministry of National

Education (Appendix G). Due to the pandemic, the researcher first called the school principals and provided information about the study. Once the verbal permission was given, the researcher sent the ethical approval taken from the Ministry of National Education to the school principals. The principals then directed the researcher to the science teachers and shared the teachers' contact information. The researcher contacted the science teachers via instant message, explained the procedure, and shared the Google Form. The researcher then asked the teachers to devote some of their online lessons to this study. Teachers asked students to fill out the Google Form sent by the researcher during the lesson. The students were required to read the researcher's message before completing the questions. As a result, the students were kept informed of the research. The three questionnaires were administered to the participants in their online classroom meeting, and they completed the questionnaire in 20-25 minutes in one class meeting. Application of the questionnaire as part of the lesson both eliminated the data collection validity threats and increased the response rate.

### **3.5 Data Analysis**

The data was analyzed using the Statistical Package for Social Sciences (SPSS), SPSS Amos, and Microsoft (MS) Excel. The five significant variables in this study were middle school students' misconceptions about astronomy concepts, attitudes toward astronomy, gender, interest in astronomy, and future occupation. The four-tier misconception about astronomy concepts test was used to assess students' misconceptions about astronomy. A closed-ended questionnaire was then used to examine their attitude towards astronomy. Statistical analyses were undertaken to identify students' correct responses to astronomy concepts, misconceptions about astronomy concepts, and attitudes toward astronomy. Also, statistical analysis was used to look into the relationship between students' misconceptions about astronomy concepts and attitudes toward astronomy.



Each student's correct answers to only the first tiers of items on the MTAC were used to generate correct-only first-tier scores. For the first tiers, the students' responses to each item were categorized as 0 (incorrect answer) or 1 (correct answer). Each student's right answer to both the first and third tiers on MTAC was then used to generate the correct first and third score. A student's response and reason were categorized as 1 when they were correct, and if incorrect, they were categorized as 0. Each student's correct answers for all tiers on MTAC were used to generate correct scores for all tiers. For the confidence tiers, the answer of a student who chose "Yes, I am sure" as well as providing the correct answer and reason, was categorized as 1, otherwise, it was categorized as 0. Students received a maximum of 10 points if they answered all of the questions on this test accurately with their reasoning and were confident in their answers.

Each student's answers, which indicated misconceptions about the first tiers of the items on the MTAC was used to generate a misconception score for the first tier. For the first tiers, students' answers to each item were categorized as either 0 (no misconception) or 1 (misconceptions). Each of a student's answers, which indicated misconceptions about both the first tiers and third tiers of the items on the MTAC was used to generate a misconception score for the first and third tiers. For the first tiers, students' answers to each item were categorized as 0 (no misconceptions) or 1 (misconceptions). For the third tier, students' answers to each item were categorized as 0 (no misconception) or 1 (misconception). Students' misconception scores were estimated at all four tiers. When students chose answers that indicated misconceptions in the first and third tiers and chose "Yes, I am sure" in the second and fourth-tiers, it was categorized as 1 for the item. More than one item in the exam assesses some misconceptions.

As a result, the correct percentages of misconceptions for all four tiers of the MTAC were assessed, as were the average percentages of the same misconceptions assessed by different items. Among the 8 misconceptions, 3 were determined to be common because their proportion was at least 10% of the sample. It was revealed that students had misconceptions about astronomy concepts when they chose the misconception

on the first tier, then the reason for the misconception on the third tier, and they were certain about both levels. Students got a maximum of 3 points since their misconceptions were determined in this study.

The relationships between students' misconceptions about astronomy concepts and their attitude toward astronomy, as well as between students' proper comprehension of astronomy concepts and their attitude toward astronomy, were investigated using Pearson correlation analysis. The correlations were computed separately for the 6th grade and 7th grade students' responses. Also, Chi-square analyses were conducted to examine relationships between 6th and 7th grade students' correct responses to astronomy concepts.

A multivariate analysis of variance (MANOVA) was also performed to explore variations in 6th and 7th grade students' misconceptions about astronomy concepts and attitudes towards astronomy in relation to gender, interest in astronomy, and future occupation.

### **3.6 Internal Validity Threats**

#### **3.6.1 Subject characteristics**

Subject characteristics such as age, maturity, and gender may have had an impact on the study (Frankel & Wallen, 2009). Subjects were chosen for this study by considering these characteristics. Age was controlled by collecting data from 6th and 7th grade students studying in Ankara/Çankaya. Moreover, data regarding gender was also collected and used as one of the independent variables. It was believed that students' interest in astronomy and future occupations might also be related to subject characteristics, thus information regarding these variables were collected and included into the study as independent variables.

### **3.6.2 Location**

Alternative explanations for results may emerge as a function of the data collection location. This is referred to as a threat from a certain location (Frankel & Wallen, 2006). Application of the questionnaire as part of the lesson helped to eliminate location threat.

### **3.6.3 Instrumentation**

Instrumentation can pose problems if the instrument's nature (including the scoring procedure) is altered in any manner. This is commonly known as instrument decay. (Frankel & Wallen, 2009). During the data collection process, data collection instruments did not change, and therefore instrumentation decay was not a threat to the study.

### **3.6.4 Testing Execution**

When the execution of a test impacts participants' responses when they are tested again, it becomes a threat to internal validity (Frankel & Wallen, 2009). Testing was not a concern in this investigation because the instruments were only utilized once. Furthermore, because the three instruments used in the study were unrelated to one another, none of the instruments could have provided clues for the other two that the students could have exploited.

### **3.6.5 Attitude of Subjects**

Internal validity may also be threatened if individuals' perceptions of the study and their participation in it are negative (Frankel & Wallen, 2009). The significance of the study was explained to the students, that they were a part of the study, and that

their participation was invaluable to the study. Thus, subject attitude was not deemed a threat to the study.

### **3.6.6 Loss of Subjects**

Internal validity is threatened when participants are absent or fail to complete examinations, questionnaires, or other instruments during data collection (Frankel & Wallen, 2009). In questionnaire studies, failure to complete or submit these instruments is extremely problematic. The questions were designed to be simple and brief so that students could finish the task without becoming uninterested, and they were required to answer a questionnaire before moving on to the next. We can be certain then that a student has completed the entire questionnaire in this way. Thus, the loss of subjects during data collection was not a threat.

## **CHAPTER FOUR**

### **RESULT**

In this chapter, for the first research question, 6th and 7th grade middle school students' misconceptions about astronomy concepts were analyzed. For the second research question, 6th and 7th grade middle school students' attitudes towards astronomy were analyzed. For the third research question, the difference between 6th and 7th grade students' attitudes towards astronomy in relation to gender, interest in astronomy, and future occupation were investigated. Next, the relationship between 6th and 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy was analyzed. Finally, the differences in 6th and 7th grade students' misconceptions about astronomy concepts in relation to gender, interest in learning astronomy, and future occupation were investigated for the focus of the last research question.

#### **4.1 Misconceptions Test about Astronomy Concepts (MTAC)**

##### **4.1.1 Misconceptions about Astronomy Concepts of 6th Grade Students**

Of the 10 questions in the Misconceptions Test About Astronomy Concepts (MTAC), misconceptions were observed for the questions given in Table 4.1. The proportions of misconceptions in the first tiers, the first and third tiers, and all four tiers of the misconception test for 6th grade students are shown in this table. All the four tier values were less than only the first tier and the first and third tier values. For this reason, four-tier misconception tests were used to diagnose the participants' misconceptions, distinguishing "lack of knowledge" from specific misconceptions.

About 11% of the average rate of misconceptions disappears as the type of test changes from only the first tier to the first and third tiers. This proportion stems from *false negatives*. Moreover, a 4% proportion of the misconceptions were eliminated as the type of test changed from the first and third tiers to all four -tiers. This rate suggests a lack of knowledge because students are not confident in the second, the fourth tier, or both. According to Caleon and Subramaniam (2010a), misconceptions are considered significant by the proportions of at least 10% of the sample. In this study, M4, M5, and M6 are considered significant as misconceptions in science; their proportions are all around 10% of the sample. This misconception is M4: "Mercury is the hottest planet in the solar system. M5: "As the Moon enters the shadow of the Earth, the phases of the Moon occur". M6: "The Moon revolves around the Earth in one month, while the Earth revolves around the Sun in one year, since these periods are different, lunar and solar eclipses do not occur every month". Additionally, since the percentage of the first, the second, the third, the seventh, and the eighth number of misconceptions in all four stages was below 10%, no misconceptions were found in the questions containing these determined misconceptions.

Table 4-1 Four -Tier Misconception Scores of 6th Grade Students

|                              | <b>Proportions of misconception values for each question</b> |           |           |           |           |           |           |           | <b>MEAN</b> |
|------------------------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|
|                              | <b>M*1**</b>   | <b>M2</b> | <b>M3</b> | <b>M4</b> | <b>M5</b> | <b>M6</b> | <b>M7</b> | <b>M8</b> |             |
| <b>All Four Tiers</b>        | 0%   | 2%        | 3%        | 9%        | 11%       | 22%       | 2%        | 4%        | 7%          |
| <b>First and Third Tiers</b> | 2%   | 5%        | 4%        | 14%       | 13%       | 34%       | 5%        | 7%        | 11%         |
| <b>Only First Tiers</b>      | 7,4%   | 16 %      | 21%       | 22%       | 28%       | 51%       | 16%       | 12%       | 22%         |

*\*M refers to misconceptions*

*\*\* numbers represent the misconception number*

Table 4.2 presents four-tier correct item percentage scores of the sixth-grade students. According to the values given in Table 4.2, all four tiers scores are the highest from both only the first tiers and the first and third tiers score. For this reason, correct responses about astronomy concepts are measured better utilizing a four-tier

test. As the type of test changes from the first tier to the first and third tiers, about 17% of the average rate of correct item percentage disappears, which means does not indicate any misconceptions and this percentage also shows the overestimated proportion of students' correct scores. Besides, 10% proportion of the misconceptions disappeared as the type of test changed from the first and third tiers to all four tiers. This proportion results from a *lack of knowledge*. Furthermore, the percentages of questions 3, 5, 6, 7, and 10 scores are low because these questions measured students' misconceptions about astronomy concepts as given in Table 4.2. Thus, the students had correct responses about the structure of the Sun, the rotation of the Moon, and the meteor shower. They also correctly indicated that "the Sun is a star"; "the Moon rotates around itself"; and "meteor showers are meteoroids that burn as they pass through the Earth's atmosphere".

Table 4-2 Four-Tier Correct Item Percentages of 6th Grade Students

|                                  | Correct responses values for each question |     |     |     |     |     |     |     |     |     | MEAN |
|----------------------------------|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
|                                  | Q1*  | Q2  | Q3  | Q4  | Q5  | Q6  | Q7  | Q8  | Q9  | Q10 |      |
| <b>All Four Tiers</b>            | 67%  | 35% | 29% | 44% | 22% | 34% | 16% | 47% | 58% | 35% | 39%  |
| <b>The First and Third Tiers</b> | 77%  | 46% | 34% | 65% | 28% | 48% | 23% | 58% | 67% | 44% | 49%  |
| <b>Only First Tiers</b>          | 89%  | 62% | 42% | 77% | 66% | 64% | 40% | 71% | 76% | 76% | 66%  |

\*Q refers to questions, numbers represent the question number in the test

#### 4.1.2 Misconceptions about Astronomy Concepts of 7th Grade Students

According to Table 4.3, as the type of test changes from only the first tier to the first and third tiers, about 11% of the average rate of misconceptions disappears. This proportion stems from false negatives. Moreover, a 4 % proportion of the misconceptions were eliminated as the test changed from the first and third tiers to all four tiers. This rate is owing to a lack of knowledge of science students' responses to the confidence tiers were negative, that is, they were not confident for the second,

or the fourth, or both of them. Also, the results showed that 7th grade students had the same misconceptions as 6th grade students. The proportions of the misconceptions for M4, M5, and M6 were all around 10% of the sample. This misconception is M4: "Mercury is the hottest planet in the solar system. M5: "As the moon enters the shadow of the Earth, the phases of the Moon occur." M6: "The Moon revolves around the Earth in one month, while the Earth revolves around the Sun in one year, since these periods are different, lunar and solar eclipses do not occur every month". In addition, since the percentage of the second, third, seventh, and eighth misconceptions in all four tiers was below 10%, no misconceptions were found in the questions containing these misconceptions.

Table 4-3 Four -Tier Misconception Scores of 7th Grade Students

|                              | <b>Proportions of misconception values for each question</b> |           |           |           |           |           |           |           | <b>MEAN</b> |
|------------------------------|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|
|                              | <b>M*1**</b>   | <b>M2</b> | <b>M3</b> | <b>M4</b> | <b>M5</b> | <b>M6</b> | <b>M7</b> | <b>M8</b> |             |
| <b>All Four Tiers</b>        | 0%   | 5%        | 1%        | 15%       | 9%        | 20%       | 1%        | 2%        | 7%          |
| <b>First and Third Tiers</b> | 1%   | 5%        | 2%        | 18%       | 15%       | 35%       | 5%        | 3%        | 11%         |
| <b>Only First Tiers</b>      | 6%   | 14%       | 15%       | 26%       | 34%       | 54%       | 15%       | 12%       | 22%         |

*\*M refers to misconceptions*

*\*\* numbers represent the misconception number*

Table 4.4 indicates that for seventh grade students, as the type of test changes from only the first tier to the first and third tiers, about 17% of the average rate of correct items disappears. Also, this percentage shows the overestimated proportion of students' correct scores for only the first tiers. Besides, 16% of the misconceptions disappeared as the type of test changed from the first and third tiers to all four -tiers. This is primarily due to a lack of knowledge. Furthermore, most of the participants were unable to answer questions 3,5, 6, 7, and 10 correctly, as given in Table 4.4 these items measured students' misconceptions about astronomy.



Table 4-4 Four-Tier Correct Item Percentages of 7th Grade Students.

|                                  | <b>Correct responses values for each question</b> |           |           |           |           |           |           |           |           |            | <b>MEAN</b> |
|----------------------------------|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|-------------|
|                                  | <b>Q1*</b>  | <b>Q2</b> | <b>Q3</b> | <b>Q4</b> | <b>Q5</b> | <b>Q6</b> | <b>Q7</b> | <b>Q8</b> | <b>Q9</b> | <b>Q10</b> |             |
| <b>All Four Tiers</b>            | 76%   | 32%       | 21%       | 43%       | 15%       | 27%       | 9%        | 55%       | 32%       | 23%        | 31%         |
| <b>The First and Third Tiers</b> | 84%   | 45%       | 29%       | 61%       | 24%       | 38%       | 13%       | 64%       | 73%       | 38%        | 47%         |
| <b>Only First Tiers</b>          | 94%   | 59%       | 36%       | 78%       | 61%       | 54%       | 36%       | 77%       | 80%       | 62%        | 64%         |

*\*Q refers to questions, numbers represent the question number in the test*

#### **4.2 Comparison of 6th and 7th Grade Students Correct responses about Astronomy Concepts**

The Misconceptions Test About Astronomy Concepts (MTAC) revealed that not only 6th grade but also 7th grade students had the same misconceptions about the features of the planet, the phases of the moon, and solar and lunar eclipse concepts. However, both 6th grade and 7th grade students had the correct responses to astronomy concepts, which are the structure of the Sun, the rotation of the Moon, and the meteor shower. They had correct responses about astronomy concepts, which were: "the Sun is a star"; "the Moon rotates around itself"; and "meteor showers are meteoroids that burn as they pass through the Earth's atmosphere". Table 4.5 presents the information regarding 6th and 7th grade middle school students' correct response scores on astronomy in the Misconceptions Test About Astronomy Concepts (MTAC).

Table 4-5 Distribution of Misconception Test about Astronomy Concepts

|             |         | <b>6</b> |          | <b>7</b> |          | <b>Total</b> |          | <b>X<sup>2</sup></b> | <b>P</b>     |
|-------------|---------|----------|----------|----------|----------|--------------|----------|----------------------|--------------|
|             |         | <b>N</b> | <b>%</b> | <b>n</b> | <b>%</b> | <b>n</b>     | <b>%</b> |                      |              |
| Question 1  | Wrong   | 119      | 33,1     | 82       | 23,6     | 201          | 28,4     | 7,84                 | <b>0,01*</b> |
|             | Correct | 241      | 66,9     | 266      | 76,4     | 507          | 71,6     |                      |              |
| Question 2  | Wrong   | 235      | 65,3     | 282      | 81,0     | 517          | 73,0     | 22,30                | <b>0,00*</b> |
|             | Correct | 125      | 34,7     | 66       | 19,0     | 191          | 27,0     |                      |              |
| Question 3  | Wrong   | 257      | 71,4     | 274      | 78,7     | 531          | 75,0     | 5,09                 | <b>0,02*</b> |
|             | Correct | 103      | 28,6     | 74       | 21,3     | 177          | 25,0     |                      |              |
| Question 4  | Wrong   | 201      | 55,8     | 198      | 56,9     | 399          | 56,4     | 0,08                 | <b>0,78</b>  |
|             | Correct | 159      | 44,2     | 150      | 43,1     | 309          | 43,6     |                      |              |
| Question 5  | Wrong   | 281      | 78,1     | 295      | 84,8     | 576          | 81,4     | 5,26                 | <b>0,02*</b> |
|             | Correct | 79       | 21,9     | 53       | 15,2     | 132          | 18,6     |                      |              |
| Question 6  | Wrong   | 238      | 66,1     | 253      | 72,7     | 491          | 69,4     | 3,62                 | <b>0,06</b>  |
|             | Correct | 122      | 33,9     | 95       | 27,3     | 217          | 30,6     |                      |              |
| Question 7  | Wrong   | 303      | 84,2     | 317      | 91,1     | 620          | 87,6     | 7,79                 | <b>0,01*</b> |
|             | Correct | 57       | 15,8     | 31       | 8,9      | 88           | 12,4     |                      |              |
| Question 8  | Wrong   | 190      | 52,8     | 156      | 44,8     | 346          | 48,9     | 4,48                 | <b>0,03*</b> |
|             | Correct | 170      | 47,2     | 192      | 55,2     | 362          | 51,1     |                      |              |
| Question 9  | Wrong   | 152      | 42,2     | 306      | 87,9     | 458          | 64,7     | 161,84               | <b>0,00*</b> |
|             | Correct | 208      | 57,8     | 42       | 12,1     | 250          | 35,3     |                      |              |
| Question 10 | Wrong   | 233      | 64,7     | 267      | 76,7     | 500          | 70,6     | 12,29                | <b>0,00*</b> |
|             | Correct | 127      | 35,3     | 81       | 23,3     | 208          | 29,4     |                      |              |

According to Table 4.5, except for questions 4 and 6, all of the questions suggested a statistical difference between 6th grade students and 7th grade students. However, the magnitude of the differences between the means of 6th and 7th grade had small effect sizes for the questions 1, 2, 7, 9, and 10 according to Cohen's (1988) criteria, which states .01 for a small effect, .03 for a medium effect, and .05 for a large effect.

Otherwise, the questions 3, 5, and 8 had medium effect sizes. Also, apart from the answers given to questions 1 and 8, 6th grade students were able to give more correct responses than 7th grade students. To be clear, students who are in 6th grade had more correct answers than students who are in 7th grade. This can be due to the fact that students start learning astronomy concepts in 5th grade. These concepts learned in 5th grade form the basis of other astronomy concepts for other grades. 7th grade students may forget these concepts that were covered in 5th and 6th grade more often due to time and so cannot learn them in a meaningful way. As a result, 7th grade students had fewer correct answers than 6th grade students.

### **4.3 Students Attitudes Toward Astronomy**

In this study, students' attitudes towards astronomy were measured by using the astronomy attitude scale (AAS). The AAS includes 27 items and a 5-point Likert scale, and 6th and 7th grade students' attitudes towards astronomy were used to examine with regard to five sub-factors of the astronomy attitude scale, which are liking, self-confidence, being interested, application, and daily life. Moreover, with the help of the astronomy attitude scale, students got an astronomy attitude score and an investigation of significant differences in students' grade level, gender, interest in astronomy, and future occupation regarding their attitude towards astronomy was conducted

Table 4-6 Descriptive Statistics of 6th and 7th grade students Gender, Interest in Astronomy, and Future Occupation in related to Sub-Factors of Astronomy Attitude Scale

|                       |                  | n   | Liking |      | Self Confidence |      | Being Interested |      | Application |      | Daily Life |       |
|-----------------------|------------------|-----|--------|------|-----------------|------|------------------|------|-------------|------|------------|-------|
|                       |                  |     | Mean   | SD   | Mean            | SD   | Mean             | SD   | Mean        | SD   | Mean       | SD    |
| Grade                 | 6                | 360 | 6,64   | 2,79 | 14,37           | 3,24 | 23,45            | 4,97 | 16,82       | 6,60 | 31,69      | 12,03 |
| Level                 | 7                | 348 | 6,54   | 2,76 | 14,50           | 3,10 | 23,84            | 4,69 | 16,94       | 6,78 | 31,32      | 12,30 |
| Gender                | Male             | 312 | 6,51   | 2,79 | 14,45           | 3,27 | 23,15            | 5,23 | 16,64       | 6,85 | 31,05      | 12,23 |
|                       | Female           | 396 | 6,66   | 2,75 | 14,42           | 3,10 | 24,03            | 4,47 | 17,07       | 6,55 | 31,87      | 12,10 |
| Interest in Astronomy | No               | 86  | 5,09   | 2,53 | 13,76           | 3,53 | 21,49            | 5,46 | 14,80       | 6,77 | 26,21      | 11,44 |
|                       | Yes              | 622 | 6,80   | 2,74 | 14,53           | 3,11 | 23,94            | 4,67 | 17,16       | 6,62 | 32,24      | 12,08 |
| Future Occupation     | Math and Science | 391 | 6,94   | 2,81 | 14,95           | 3,17 | 24,13            | 4,58 | 17,77       | 6,66 | 33,35      | 12,28 |
|                       | Social Science   | 294 | 6,12   | 2,68 | 13,78           | 3,10 | 23,00            | 5,11 | 15,64       | 6,64 | 29,07      | 11,80 |

Table 4.6 showed that 6th grade students showed more positive attitudes about the sub-factors of "liking" and "daily life" than 7th grade students. On the other hand, 7th grade students showed more positive attitudes towards the sub-factors of "self-confidence," "being interested" and "application" than 6th grade students. Moreover, male students had more positive attitudes towards astronomy being directly related to self-confidence, whereas female students had more positive attitudes towards astronomy being directly linked to daily life, liking, application, and being interested. Furthermore, students who were engaged in astronomy topics had more positive feelings about astronomy being directly linked to daily life, like, application, being interested, and self-confidence. Furthermore, students who chose occupations connected to math and science had higher scores on all sub-factors, including liking, self-confidence, being interested, application, and daily life, than students who chose occupations related to social science.

Table 4-7 Multivariate Tests Result of 6th and 7th Grade Students for The Gender, Interested in Astronomy and Future Occupation in relation to Attitude Towards Astronomy

| Effect                   |                  | Value | F                  | Hypothesis<br>df | Effor df | Sig. | Partial<br>Eta<br>Squared |
|--------------------------|------------------|-------|--------------------|------------------|----------|------|---------------------------|
| Grade<br>Level           | Wilks'<br>Lambda | .99   | .76 <sup>b</sup>   | 5.000            | 702.000  | .58  | .01                       |
| Gender                   | Wilks'<br>Lambda | .98   | 2.37 <sup>b</sup>  | 5.000            | 702.000  | .04  | .02                       |
| Interest in<br>Astronomy | Wilks'<br>Lambda | .92   | 12.30 <sup>b</sup> | 5.000            | 702.000  | .00  | .08                       |
| Future<br>Occupation     | Wilks'<br>Lambda | .94   | 8.20 <sup>b</sup>  | 5.000            | 679.000  | .00  | .06                       |

When Table 4.7 was examined, there was no significant difference between 6th and 7th-grade students about their astronomy attitude scores for all sub-factors,  $F(5,702) = 0.76$ ,  $p = 0.58$ , Wilk's lambda = 0.1, partial eta squared = 0.01. In other words, 6th and 7th grade students have the same positive level of attitude in terms of the sub-factors of "daily life, application, being interested, self-confidence, and liking." Furthermore, there was a significant difference in attitude scores based on gender,  $F(5,702) = 2.37$ ,  $p = 0.04$ , Wilk's lambda = 0.98, partial eta squared = 0.02. It indicates that the effect size was small by using Cohen's (1988) criterion.

Also, there was a relationship between students who are interested in astronomy and those who are not interested in astronomy on their attitude score,  $F(5,702) = 12.30$ ,  $p = 0.00$ , Wilk's lambda = 0.92 and partial eta squared = 0.08, which indicates a medium effect size by using Cohen's (1988) criterion. Moreover, there was a relationship between students who chose occupations about math and science and those who chose occupations about social science on their attitude score,  $F(5,679) = 8.20$ ,  $p = 0.00$ , Wilk's lambda = 0.94, partial eta squared = 0.06, which indicates medium effect size by using Cohen's criteria.

Table 4-8 Test of Between Subject

| Source                  | Dependent Variable | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared |
|-------------------------|--------------------|-------------------------|----|-------------|-------|------|---------------------|
| Grade Level             | Liking             | 1.93                    | 1  | 1.93        | .25   | .62  | .00                 |
|                         | Self Confidence    | 2.89                    | 1  | 2.89        | .29   | .59  | .00                 |
|                         | Being Interested   | 26.79                   | 1  | 26.79       | 1.15  | .29  | .00                 |
|                         | Application        | 2.44                    | 1  | 2.44        | .05   | .82  | .00                 |
|                         | Daily Life         | 24.58                   | 1  | 24.58       | .17   | .68  | .00                 |
| Gender                  | Liking             | 3.94                    | 1  | 3.94        | .51   | .47  | .00                 |
|                         | Self Confidence    | .16                     | 1  | .16         | .02   | .90  | .00                 |
|                         | Being Interested   | 134.26                  | 1  | 134.26      | 5.79  | .02* | .01                 |
|                         | Application        | 31.94                   | 1  | 31.94       | .72   | .40  | .00                 |
|                         | Daily Life         | 118.24                  | 1  | 118.24      | .80   | .37  | .00                 |
| Interested in Astronomy | Liking             | 219.48                  | 1  | 219.48      | 29.79 | .00* | .04                 |
|                         | Self Confidence    | 45.16                   | 1  | 45.16       | 4.51  | .03* | .01                 |
|                         | Being Interested   | 453.72                  | 1  | 453.71      | 19.94 | .00* | .03                 |
|                         | Application        | 421.40                  | 1  | 421.40      | 9.55  | .00* | .01                 |
|                         | Daily Life         | 2748.89                 | 1  | 2748.80     | 19.08 | .00* | .03                 |
| Future Occupation       | Liking             | 112.49                  | 1  | 112.49      | 14.82 | .00* | .02                 |
|                         | Self Confidence    | 227.37                  | 1  | 227.37      | 23.09 | .00* | .03                 |
|                         | Being Interested   | 216.73                  | 1  | 216.72      | 9.34  | .00* | .01                 |
|                         | Application        | 763.46                  | 1  | 763.46      | 17.27 | .00* | .03                 |
|                         | Daily Life         | 3076.30                 | 1  | 3076.30     | 21.08 | .00* | .03                 |

Following confirmation of the multivariate tests' significance, further examination of each of the dependent variables was conducted. In the test of between-subjects' effects, this information is provided in Table 4.8. Table 4.8 demonstrated that the only disparity between males and females was the sub-factor of being interested  $F(1,706) = 5.79, p = 0.02$ , partial eta squared = 0.01. It indicates that the effect size was small by using Cohen's (1988) criterion. In terms of being interested, there was a considerable disparity between male and female students. Furthermore, there was a significant impact of interest in astronomy on liking,  $F(1,706) = 29.79, p = 0.00$ , partial eta squared = 0.04, on self-confidence,  $F(1,706) = 4.51, p = 0.03$ , partial eta squared = 0.01, on being interested  $F(1,706) = 19.94, p = 0.00$ , partial eta squared = 0.03 on application,  $F(1,706) = 9.55, p = 0.00$ , partial eta squared = 0.01 and on daily life,  $F(1,706) = 19.08, p = 0.00$ , partial eta squared = 0.00. All of the effect sizes are small according to Cohen's criteria (1986). This finding revealed that students who are interested in astronomy have a favourable attitude toward learning about astronomy subjects more effectively and easily through practice. Moreover, future occupation had a significant effect on liking  $F(1,683) = 14.82, p = 0.00$ , partial eta squared = 0.02, on self-confidence  $F(1,683) = 23.09, p = 0.00$ , partial eta squared = 0.033, on being interested  $F(1,683) = 9.34, p = 0.02$ , partial eta squared = 0.01 application  $F(1,683) = 17.27, p = 0.00$ , partial eta squared = 0.03 and on daily life  $F(1,683) = 21.09, p = 0.00$ , partial eta squared = 0.03. All of the effect sizes are small according to Cohen's criteria (1986).

In the present study, when there are three or more levels of independent variables, it is required to do follow-up univariate studies to determine where the significant differences are (Pallant, 2011). On the other hand, there were only two levels for independent variables (gender, interest in astronomy, and future occupation). As aforementioned, there is a significant difference between gender and the sub-factors of being interested. To find out who had the high score, an estimated marginal means was provided. As a result, according to the table 4.9, for being interested, the mean score for males was 22.55 and for females, it was 22.34. An examination of the mean

scores indicated that males reported slightly higher levels of being interested ( $M = 22.55$ ,  $SD = 0.34$ ) than females ( $M = 22.34$ ,  $SD = 0.48$ ).

Table 4-9 Estimated Marginal Means in Terms of Gender

| Dependent Variable | Gender | Mean  | Std. Error | 95% Confidence Interval |             |
|--------------------|--------|-------|------------|-------------------------|-------------|
|                    |        |       |            | Lower Bound             | Upper Bound |
| Being Interested   | Male   | 22.55 | .38        | 21.79                   | 23.30       |
|                    | Female | 22.34 | .48        | 21.41                   | 23.27       |

As mentioned, there is a significant interest in astronomy on all the sub-factors of the astronomy attitude scale (AAS). According to table 4.10, in terms of liking, an inspection of the mean scores indicated that students who are interest in astronomy reported slightly higher levels of liking ( $M = 6.73$ ,  $SD = 0.12$ ) than students who are not interest in astronomy ( $M = 4.95$ ,  $SD = 0.33$ ). In terms of self-confidence, an inspection of the mean scores indicated that students who are interest in astronomy reported slightly higher levels of self-confidence ( $M = 14.14$ ,  $SD = 0.13$ ) than students who are not interest in astronomy ( $M = 13.37$ ,  $SD = 0.38$ ). In terms of being interested, an inspection of the mean scores indicated that students who are interest in astronomy reported slightly higher levels of being interested ( $M = 23.70$ ,  $SD = 0.20$ ) than students who are not interest in astronomy ( $M = 21.19$ ,  $SD = 0.58$ ). In terms of application, an inspection of the mean scores indicated that students who are interest in astronomy reported slightly higher levels of application ( $M = 17.00$ ,  $SD = 0.28$ ) than students who are not interest in astronomy ( $M = 14.89$ ,  $SD = 0.81$ ). In terms of daily life, an inspection of the mean scores indicated that students who are interest in astronomy reported slightly higher levels of daily life ( $M = 31.84$ ,  $SD = 0.51$ ) than students who are not interest in astronomy ( $M = 25.47$ ,  $SD = 1.46$ ).



Table 4-10 Estimated Marginal Means in Terms of Interest in Astronomy

| Dependent Variable | Interest in Astronomy | Mean  | Std. Error | 95% Confidence Interval |             |
|--------------------|-----------------------|-------|------------|-------------------------|-------------|
|                    |                       |       |            | Lower Bound             | Upper Bound |
| Liking             | No                    | 4.95  | .33        | 4.30                    | 5.60        |
|                    | Yes                   | 6.73  | .12        | 6.51                    | 6.96        |
| Self Confidence    | No                    | 13.38 | .38        | 12.63                   | 14.13       |
|                    | Yes                   | 14.41 | .13        | 14.16                   | 14.67       |
| Being Interested   | No                    | 21.19 | .58        | 20.06                   | 22.32       |
|                    | Yes                   | 23.70 | .20        | 23.31                   | 24.09       |
| Application        | No                    | 14.89 | .81        | 13.30                   | 16.47       |
|                    | Yes                   | 17.01 | .28        | 16.46                   | 17.56       |
| Daily Life         | No                    | 25.47 | 1.46       | 22.60                   | 28.33       |
|                    | Yes                   | 31.84 | .51        | 30.85                   | 32.83       |

As mentioned, there is a significant future occupation on all the sub-factors of the astronomy attitude scale (AAS). According to table 4.11, in terms of liking, an inspection of the mean scores indicated that students who chose an occupation related to math and science reported slightly higher levels of liking ( $M = 6.48$ ,  $SD = .24$ ) than students who chose an occupation related to social science ( $M = 5.21$ ,  $SD = 0.26$ ). In terms of self-confidence, an inspection of the mean scores indicated that students who chose an occupation related to math and science reported slightly higher levels of self-confidence ( $M = 14.40$ ,  $SD = .27$ ) than students who chose an occupation related to social science ( $M = 13.39$ ,  $SD = 0.30$ ). In terms of being interested, an inspection of the mean scores indicated that students who chose an occupation related to social science reported slightly higher levels of being interested ( $M = 22.55$ ,  $SD = .45$ ) than students who chose an occupation related to math and science ( $M = 22.34$ ,  $SD = 0.41$ ). In terms of application, an inspection of

the mean scores indicated that students who chose an occupation related to math and science reported slightly higher levels of application ( $M = 17.79, SD = .58$ ) than students who chose an occupation related to social science ( $M = 14.11, SD = 0.63$ ). In terms of daily life, an inspection of the mean scores indicated that students who chose an occupation related to math and science reported slightly higher levels of daily life ( $M = 32.02, SD = 1.05$ ) than students who chose an occupation related to social science ( $M = 22.29, SD = 1.14$ ).

Table 4-11 Estimated Marginal Means in Terms of Future Occupation

| Dependent Variable | Future Occupation | Mean  | Std. Error | 95% Confidence Interval |             |
|--------------------|-------------------|-------|------------|-------------------------|-------------|
|                    |                   |       |            | Lower Bound             | Upper Bound |
| Liking             | Math and Science  | 6.48  | .24        | 6.01                    | 6.95        |
|                    | Social Science    | 5.21  | .26        | 4.70                    | 5.71        |
| Self Confidence    | Math and Science  | 14.40 | .27        | 13.86                   | 14.94       |
|                    | Social Science    | 13.39 | .30        | 12.81                   | 13.97       |
| Being Interested   | Math and Science  | 22.34 | .41        | 21.53                   | 23.15       |
|                    | Social Science    | 22.55 | .45        | 21.67                   | 23.43       |
| Application        | Math and Science  | 17.79 | .58        | 16.65                   | 18.92       |
|                    | Social Science    | 14.11 | .63        | 12.87                   | 15.34       |
| Daily Life         | Math and Science  | 32.02 | 1.05       | 29.97                   | 34.08       |
|                    | Social Science    | 25.29 | 1.14       | 23.06                   | 27.52       |

#### 4.4 The Relationships 6th Grade Middle School Students' Misconceptions about Astronomy Concepts and Their Attitudes Towards Astronomy

So as to investigate the relationship between 6th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy, the

Pearson correlation coefficient was evaluated after a simple linear correlation was performed. According to table 4.12, there were positive correlations between students' correct responses about astronomy concepts scores and liking, self-confidence, being interested, application, and daily life scores. However, the effect size of these sub-factors of the astronomy attitude scale is small by utilizing Cohen's (1988) criterion, which means the mean differences were statistically and practically significant. Also, there was a positive relationship between students' misconception scores and liking, self-confidence, and daily life. Their effect size can be characterized as tiny by utilizing Cohen's (1988) criterion because a correlation value of .10 is regarded to suggest a weak or small link.

Table 4-12 Relationship of Correct Responses Score and Misconception Score

|                   |   | Correct responses Score | Misconception Score |
|-------------------|---|-------------------------|---------------------|
| Liking            | r | ,25**                   | ,14**               |
|                   | p | 0,00                    | 0,01                |
| Self Confidence   | r | ,26**                   | ,16**               |
|                   | p | 0,00                    | 0,00                |
| Being Interested  | r | ,26**                   | 0,03                |
|                   | p | 0,00                    | 0,57                |
| Application       | r | ,13**                   | 0,09                |
|                   | p | 0,02                    | 0,09                |
| Daily Life        | r | ,18**                   | ,16**               |
|                   | p | 0,00                    | 0,09                |
| Total of Attitude | r | ,26**                   | ,16**               |
|                   | p | 0,00                    | 0,01                |

#### 4.5 The Relationships 7th Grade Middle School Students' Misconceptions about Astronomy concepts and Their Attitudes Towards Astronomy

So as to investigate the relationship between 7th grade middle school students' misconceptions about astronomy concepts and their attitudes towards astronomy, the Pearson correlation coefficient was checked after a simple linear correlation was performed. According to table 4.13, there were positive correlations between

students' correct responses scores and liking, being interested, daily life scores, and self-confidence. However, the effect size of these sub- factors of the astronomy attitude scale is small by using Cohen's (1988) criterion, which means the mean differences were found to be statistically and practically significant. On the other hand, there was no link between students' misconception scores and liking, as well as self-confidence, being-interested, and application, including daily life.

Table 4-13 Relationship of Correct Responses and Misconception Score

|                   |   | <b>Correct Responses Score</b> | <b>Misconception Score</b> |
|-------------------|---|--------------------------------|----------------------------|
| Liking            | r | ,21**                          | 0,06                       |
|                   | p | 0,00                           | 0,27                       |
| Self Confidence   | r | ,32**                          | 0,03                       |
|                   | p | 0,00                           | 0,58                       |
| Being Interested  | r | ,22**                          | 0,04                       |
|                   | p | 0,00                           | 0,49                       |
| Application       | r | 0,10                           | 0,04                       |
|                   | p | 0,06                           | 0,42                       |
| Daily Life        | r | ,22**                          | 0,04                       |
|                   | p | 0,00                           | 0,43                       |
| Total of Attitude | r | ,26**                          | 0,06                       |
|                   | p | 0,00                           | 0,31                       |

#### **4.6 Students' Misconceptions about Astronomy Concepts in relation to Gender, Interest in Astronomy, And Future Occupation**

In this part of the study, the investigation of significant differences between 6th and 7th grade students' correct response scores and misconception scores in relation to gender, interest in astronomy, and future occupation was checked. Grade level, gender, interest in astronomy, and future occupation differences were investigated using a one-way between-groups multivariate analysis of variance. In the MANOVA analysis, the correct response score and the misconception score were used as

dependent variables, and gender, interest in astronomy, and future occupation were used as independent variables.

Table 4-14 Multivariate Tests Result of 6th Grade Students for The Gender, Interest in Astronomy and Future Occupation in relation to Correct response and Misconception Score

| Effect                   |                  | Value | F                 | Hypothesis<br>df | Effor df | Sig. | Partial<br>Eta<br>Squared |
|--------------------------|------------------|-------|-------------------|------------------|----------|------|---------------------------|
| Gender                   | Wilks'<br>Lambda | .97   | 5.24 <sup>b</sup> | 2.000            | 340.000  | .01  | .03                       |
| Interest in<br>Astronomy | Wilks'<br>Lambda | .96   | 7.34 <sup>b</sup> | 2.000            | 340.000  | .00  | .04                       |
| Future<br>Occupation     | Wilks'<br>Lambda | .99   | 2.60 <sup>b</sup> | 2.000            | 340.000  | .08  | .02                       |

According to table 4.14, there was a significant difference between gender and correct response scores and misconception scores,  $F(2,340) = 5.24$ ,  $p = 0.01$ , Wilks' Lambda = 0.97, partial eta squared = 0.03. There was a significant difference between interested in astronomy and correct response scores and misconception scores,  $F(2,340) = 7.34$ ,  $p = 0.00$ , Wilks' Lambda = 0.96, partial eta squared = 0.04. There was also no statistically significant difference between future occupation and correct response score and misconception score,  $F(2,340) = 2.60$ ,  $p = 0.08$ , Wilks' Lambda = 0.99, partial eta squared = 0.02, according to the multivariate test.

Table 4-15 Tests of Between-Subjects Effects

| Source                | Dependent Variable     | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared |
|-----------------------|------------------------|-------------------------|----|-------------|-------|------|---------------------|
| Gender                | Correct Response Score | 3.46                    | 1  | 3.458       | .57   | .45  | .00                 |
|                       | Misconception Score    | 3.86                    | 1  | 3.858       | 10.22 | .00  | .03                 |
| Interest in Astronomy | Correct Response Score | 72.75                   | 1  | 72.745      | 12.02 | .00  | .03                 |
|                       | Misconception Score    | 1.34                    | 1  | 1.337       | 3.54  | .06  | .01                 |
| Future Occupation     | Correct Response Score | 7.69                    | 1  | 7.692       | 1.27  | .26  | .00                 |
|                       | Misconception Score    | 1.37                    | 1  | 1.371       | 3.63  | .06  | .01                 |

Table 4.15 indicated that while there was no significant effect of gender on correct response scores  $F(7,341) = 0.57$ ,  $p = 0.45$ , partial eta square = 0.00, there was a significant effect of gender on misconceptions scores  $F(7,341) = 10.22$ ,  $p = 0.00$ , partial eta square = 0.03. It indicates that the effect size was small by using Cohen's (1988) criterion. Moreover, there was a significant difference between students who are interested in astronomy and students who are not interested in astronomy in terms of correct response score  $F(7,341) = 12.02$ ,  $p = 0.00$ , partial eta squared = 0.03. It indicates that the effect size was small by using Cohen's (1988) criterion. Furthermore, there was no significant difference in misconceptions scores between students who are interested in astronomy and students who are not interested in astronomy  $F(7,341) = 3.54$ ,  $p = 0.06$ , partial eta squared = 0.01. Besides, there was no significant difference between students who chose math and science and social science in terms of correct responses scores  $F(7,341) = 1.27$ ,  $p = 0.26$ , partial eta squared = 0.00, and in terms of misconception score  $F(7,341) = 3.63$ ,  $p = 0.06$ , partial eta squared = 0.01.

Table 4-16 Estimated Marginal Means in terms of Gender

| Dependent Variable  | Gender | Mean | Std. Error | 95% Confidence Interval |             |
|---------------------|--------|------|------------|-------------------------|-------------|
|                     |        |      |            | Lower Bound             | Upper Bound |
| Misconception Score | Male   | .64  | .06        | .51                     | .76         |
|                     | Female | .28  | .09        | .09                     | .46         |

As previously stated, there is a significant gender difference in misconception scores. An estimated marginal mean was provided to find out who had the high score. As a result, according to table 4.16, an inspection of the mean scores indicated that male students reported higher levels of misconception scores ( $M = 0.64$ ,  $SD = .06$ ) than female students ( $M = 0.28$ ,  $SD = 0.09$ ).

Table 4-17 Estimated Marginal Means in terms of Interested in Astronomy

| Dependent Variable     | Interest in Astronomy | Mean | Std. Error | 95% Confidence Interval |             |
|------------------------|-----------------------|------|------------|-------------------------|-------------|
|                        |                       |      |            | Lower Bound             | Upper Bound |
| Correct Response Score | No                    | 2.44 | .43        | 1.60                    | 3.28        |
|                        | Yes                   | 4.00 | .14        | 3.72                    | 4.28        |

According to table 4.17, an examination of the mean scores indicated that students who are interest in astronomy reported higher levels of correct response scores ( $M = 4.00$ ,  $SD = 0.14$ ) than students who are not interest in astronomy ( $M = 2.44$ ,  $SD = 0.43$ ).

Table 4-18 Multivariate Tests Result of 7th Grade Students for The Gender, Interest in Astronomy and Future Occupation in relation to Correct Response and Misconception Score

| Effect                  |               | Value | F                 | Hypothesis df | Error df | Sig. | Partial Eta Squared |
|-------------------------|---------------|-------|-------------------|---------------|----------|------|---------------------|
| Gender                  | Wilks' Lambda | .99   | 1.98 <sup>b</sup> | 2.000         | 327.000  | .14  | .01                 |
| Interested in Astronomy | Wilks' Lambda | .97   | 5.15 <sup>b</sup> | 2.000         | 327.000  | .01  | .03                 |
| Future Occupation       | Wilks' Lambda | .98   | 3.50 <sup>b</sup> | 2.000         | 327.000  | .03  | .02                 |

Table 4.18 revealed that there was a considerable difference correct response score and misconception score based on interest in astronomy  $F(2,327) = 5.15$   $p = 0.01$  partial eta squared = 0.03 and based on occupation  $F(2,327) = 3.50$   $p = 0.03$  partial eta squared = 0.02. It indicates that the effect size was small by using Cohen's (1988) criterion. On the other hand, there was no significant difference in correct response score and misconception score based on gender,  $F(2,327) = 1.98$   $p = 0.14$ ; Wilk's lambda = 0.99, partial eta squared = 0.01.

Table 4-19 Tests of Between-Subjects Effects

| Source                  | Dependent Variable     | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared |
|-------------------------|------------------------|-------------------------|----|-------------|-------|------|---------------------|
| Gender                  | Correct Response Score | 7.657                   | 1  | 7.657       | 2.16  | .14  | .01                 |
|                         | Misconception Score    | .664                    | 1  | .664        | 1.850 | .18  | .01                 |
| Interested in Astronomy | Correct Response Score | 19.464                  | 1  | 19.464      | 5.482 | .02  | .016                |
|                         | Misconception Score    | 1.713                   | 1  | 1.713       | 4.771 | .03  | .014                |
| Future Occupation       | Correct Response Score | 22.698                  | 1  | 22.698      | 6.393 | .01  | .019                |
|                         | Misconception Score    | .236                    | 1  | .236        | .657  | .42  | .002                |



Table 4.19 showed that there was no considerable effect of gender on correct response score  $F(7,328) = 2.16$ ,  $p = 0.14$ , partial eta squared = 0.01 and misconception score  $F(7,328) = 1.85$ ,  $p = 0.18$ , partial eta square = 0.01. There was no difference between male and female students on both correct response scores and misconception scores. There was also a significant difference in the correct response score  $F(7,328) = 5.48$ ,  $p = 0.02$ , partial eta squared = 0.02, and the misconception score  $F(7,328) = 4.77$ ,  $p = 0.03$ , partial eta squared = 0.01. It indicates that the effect size was small by using Cohen's (1988) criterion. Besides, although there was a significant difference between students who chose occupation related to math science, and social science, the correct response score  $F(7,328) = 6.39$ ,  $p = 0.01$ , partial eta squared = 0.02, which indicates that the effect size was small by using Cohen's (1988) criterion. There was no significant difference between students who chose occupations related to math and science and social science in terms of misconception scores  $F(7,328) = 0.65$ ,  $p = 0.42$ , partial eta squared = 0.01.

Table 4-20 Estimated Marginal Means in terms of Interested in Astronomy

| Dependent Variable     | Interested in Astronomy | Mean | Std. Error | 95% Confidence Interval |             |
|------------------------|-------------------------|------|------------|-------------------------|-------------|
|                        |                         |      |            | Lower Bound             | Upper Bound |
| Correct Response Score | No                      | 2.20 | .33        | 1.55                    | 2.84        |
|                        | Yes                     | 3.01 | .12        | 2.79                    | 3.24        |
| Misconception Score    | No                      | .22  | .10        | .09                     | .43         |
|                        | Yes                     | .47  | .04        | .39                     | .54         |

According to table 4.20, an examination of the mean scores indicated that students who are interest in astronomy reported higher levels of correct response scores ( $M = 3.01$ ,  $SD = 0.12$ ) than students who are not interest in astronomy ( $M = 2.20$ ,  $SD = 0.33$ ). In terms of misconception score, an inspection of the mean scores indicated

that students who are interest in astronomy reported higher levels of misconception score ( $M = 0.47$ ,  $SD = 0.04$ ) than students who are not interest in astronomy ( $M = 0.22$ ,  $SD = 0.10$ ).

Table 4-21 Estimated Marginal Means in terms of Future Occupation

| Dependent Variable     | Future Occupation | Mean | Std. Error | 95% Confidence Interval |             |
|------------------------|-------------------|------|------------|-------------------------|-------------|
|                        |                   |      |            | Lower Bound             | Upper Bound |
| Correct Response Score | Math and Science  | 3.05 | .27        | 2.51                    | 3.58        |
|                        | Social Science    | 2.17 | .22        | 1.74                    | 2.59        |

According to table 4.21, an examination of the mean scores indicated that students who chose an occupation related to math and science reported higher levels of correct response scores ( $M = 3.05$ ,  $SD = 0.27$ ) than students who chose an occupation related to social science ( $M = 2.17$ ,  $SD = 0.22$ ).

## **CHAPTER FIVE**

### **DISCUSSION**

#### **5.1 Summary of the Study**

This study was conducted with the participation of 360 students in 6th grade and 348 in 7th grade studying in Ankara during the fall semester of the 2020–2021 academic years. The Misconceptions Test About Astronomy Concepts (MTAC), the Attitude Astronomy Scale (AAS), which was developed by Türk and Kalkan (2015), and a demographic questionnaire were used to collect data. In this study, correlational and causal-comparative research methods were also used. Statistical analyses were performed to analyze 6th and 7th grade middle school students' misconceptions about astronomy concepts as well as students' attitudes towards astronomy. Also, a correlational research method was used to investigate relationships between 6th and 7th grade middle school students' attitudes towards astronomy and their misconceptions about astronomy concepts. Finally, a causal-comparative research method was used to investigate differences in terms of gender, interest in astronomy, and future occupation for 6th and 7th grade middle school students' misconceptions about astronomy concepts and attitudes towards astronomy.

#### **5.2 Misconceptions about Astronomy Concepts Of 6th And 7th Grade Middle School Students**

In the current study, to create a Misconceptions About Astronomy Test (MTAC), eight misconceptions were selected to measure 6th and 7th grade middle school

students' misconceptions about astronomy concepts. In detail, all of the students' misconceptions about astronomy concepts from the studies were compiled. Mercury is the hottest planet in the solar system. It was the first misconception, and it is held by a higher percentage of 7th grade students (15%) than 6th grade students (9%). This misconception was also found in the study that was conducted by LoPresto and Murrell (2011) with their students. In their study, this misconception was deemed as a major misconception because fewer than 20% responded correctly. This might be due to the fact that Mercury is the closest planet to the sun, therefore most students claim that it is the hottest planet in the solar system. To be clear, one of the objectives of the 6th grade science curriculum in Turkey is that "planets are listed in order of their distance from the Sun" and in the solar system illustration, students see Mercury as the closest planet to the Sun and according to common sense, entities that are closer to hot objects should therefore have higher surface temperatures. For example, people who are closer to a heater feel warmer in their faces and hands than those who are further away from the heater. The same is true for the Sun, almost a massive heater of sorts, and the planets orbiting around it. However, it is Venus, not Mercury, that is the hottest planet in the solar system due to the hothouse effect of its atmosphere.

In addition to this, the statement that "as the Moon enters the shadow of the Earth, the phases of the Moon occur" was also determined as a misconception to be used in this study. The outcomes of this study are consistent with other studies on the understanding of moon phases that have been published. According to Göncü (2013), 5th grade students commonly had this misconception. Baxter (1989) identified in his study that middle school students as a whole mostly had this misconception about the phases of the Moon. In addition, a study conducted by Dunlop (2000) concurred that many middle school students had this misconception. Sadler (1992) found that almost 50% of the high school students who participated in his study still believed that as the Moon enters the shadow of the Earth, the phases of the Moon occur. More alarming, a study by Trumper (2014) identified that 47,4 % of preservice teachers held the misconception that the phases of the Moon are formed by the Earth's

shadow. Moreover, according to Kanlı (2014), some preservice physics teachers, preservice science teachers, and physics teachers all had this misconception. Students or teachers who have this misconception may consequently be confused about the reason for the lunar eclipse as opposed to the phases of the Moon. According to Stahly, Krockover, and Shepardson (1999), this was described as an “eclipse explanation”. To conclude, regardless of age and grade level, significant percentages of both students and teachers have misconceptions about the phases of the Moon. In regards to many preservice and in-service teachers having this misconception, it could be one of the key factors in furthering this misconception in students.

The last statement used was "the Moon revolves around the Earth in one month, while the Earth revolves around the Sun in one year. These periods are different therefore lunar and solar eclipses do not occur every month", was determined as a misconception in the study. The findings of this study are consistent with those of a variety of other investigations. For instance, Bostan (2008) highlighted that this misconception was common among 7th grade, high school, and university students, though it was the most prevalent among 7th grade students. According to Küçüközer (2007), this was also determined as a misconception among university students to a lesser degree. This could be because these students with this misconception may struggle with understanding the nature of the Earth's, Sun's, and Moon's orbits, as well as the phases of the Moon. As a result, students' fail to fully learn this concept, making it inevitable for learners to have this misconception about eclipses. This can be due in part because the sun and moon eclipse are shown in two-dimensional images in certain textbooks, and most textbooks do not illustrate the approximately 5-degree tilt in the orbit of the Moon around the Earth. For these reasons, students may develop this misconception at an early stage.

According to some studies, the Sun is not a star, which is a common misconception (Direkçi, 2014; Serttaş & Türkoğlu, 2020; Şahin, et al., 2013). However, this was not determined to be a prevalent misconception for the purposes of this study. The

Turkish science curriculum, which was adopted in 2013, did not include any topics related to the structure of the Sun. However, the revised curriculum issued in 2018 now emphasizes this concept. For this reason, this misconception was irrelevant in this study. Recent research has revealed another misconception about the Moon's rotation (Trumper, 2001a; LoPresto & Murrell, 2011; Göncü, 2013). Göncü (2013) conducted a study with 636 students (293 in 5th grade and 343 in 7th grade) to diagnose misconceptions about astronomy concepts by using three-tier misconception tests. According to the result, most of the misconceptions were confirmed, such as "the Moon does not rotate around itself". However, in the present study, the misconception did not emerge as significantly as the previous studies. Along with the revised curriculum regarding the Sun, the rotation and revolution of the Moon is also highlighted as a specific objective. Therefore, this curricular change may be the reason why it was not determined in this study. Furthermore, in contrast to this study, the statement that "the meteor shower is a displacement of a star and the meteor is a star" was determined as a misconception in some studies (Şahin, et al., 2013; Kanlı, 2014). Again, the difference being now the concept of meteor is highlighted as an objective in the revised curriculum in Turkey.

Besides the revised curriculum, earth and universe units are now covered in the first unit for all grades of middle school. These changes have eliminated some misconceptions. Before the revised curriculum, these units were covered as the last units at the end of the second semester. Because student and instructor performance tend to decline by the conclusion of the second semester, this could result in a drop-in teaching quality. Furthermore, teachers can end up behind schedule on the curriculum. Therefore, they do not have enough time to teach these earth and universe units and are unable to cover astronomy concepts. Consequently, these topics are seldom instructed in a good way, so students' prior knowledge and misconceptions about astronomy concepts cannot change. With this in mind, if a student's prior knowledge was wrong, it would be difficult to correct the learning process of astronomy concepts (Frede, 2008).

Bonito and Almeida (2016) conducted a study involving 23 third-grade students. The purpose of this study was to see whether integrating information and communication technology (ICT) would aid students in overcoming their misconceptions about astronomy or not. According to its findings, the majority of students believed that all planets have a solid surface. However, that misconception was not found in this study. Bonito and Almedia (2016) developed and used a questionnaire that included both open and closed questions. This questionnaire mostly contained multiple-choice questions and true-or-false questions with justifications. The misconception that all planets have solid surfaces was determined by a true-false question. This can be a disadvantage while analyzing the students' answers in-depth because it cannot be known on what basis the students choose the true or false answer. In contrast, a four-tier test is a set of justifications for the answers of the first tier and provides information about the level of confidence. In this way, four-tier tests enable deep insight into students' true misconceptions and how they may have reached correct responses. That's why the misconceptions are measured with more accuracy with the four-tier tests (Kaltakçı & Eryılmaz, 2010).

### **5.3 6th And 7th Grade Middle School Students Attitude Toward Astronomy**

In this study, 6th and 7th grade students' attitudes towards astronomy were also examined. For this purpose, the Astronomy Attitude Scale (AAS), which was developed by Türk and Kalkan (2015), was used. AAS consists of five sub-factors, which are: liking astronomy, interest in astronomy, self-confidence, application of concepts, and daily life use. According to the findings, there was no significant difference between 6th and 7th grade students in their attitudes towards astronomy for all sub-factors; that is, 6th and 7th grade students had the same positive attitudes towards astronomy. Türk and Demir (2016) used this same scale (AAS) and found that preservice teachers' attitudes towards astronomy scores were not different concerning their grades. To clarify, preservice teachers did not show a positive

correlation towards the sub-factors of liking and self-confidence while they did show relatively positive attitudes towards the sub-factors of daily life, application, and being interested. Nilsen and Angell (2014) also found that 8th grade students had a positive attitude towards astronomy. Moreover, their findings indicate that attitudes towards astronomy contributed to success in learning of astronomy concepts.

According to Dede (1995), elementary students find astronomy concepts to be significantly more engaging than other science concepts. Students can improve a positive attitude toward astronomy as a result of these attractions and interests. Based on that, the students in this study tend to have a positive attitude towards astronomy, so it is plausible to assume that they are interested in astronomy as well. Moreover, according to Wittman (2009), students develop positive attitudes towards the physical sciences as a result of their positive attitudes towards astronomy. Hence, positive attitudes toward astronomy are necessary not only for learning astronomy concepts, but also for understanding physical science concepts.

#### **5.4 Correct Responses about Astronomy Concepts and Attitude Towards Astronomy**

This present study also found that for 6th grade students, there was a relationship between their correct responses about astronomy concepts and their attitude towards astronomy in terms of all sub-factors, whereas, for 7th grade students, there was a relationship between students' correct responses about astronomy concepts and their attitude towards astronomy for only the sub-factors of liking, being interested, application, and self-confidence but not for daily life use. In regards to misconceptions, there was no relationship between misconceptions and attitudes towards astronomy for 7th grade students. However, there was a relationship between misconceptions about astronomy concepts and attitudes towards astronomy in terms of sub-factors such as liking, self-confidence, and daily life use for 6th grade students. Similar findings were also reported in the study that was conducted by Bektaşlı (2016). He found that preservice science teachers who have moderate or



high attitudes show a higher understanding of astronomy concepts than preservice science teachers who have a low attitude towards astronomy. He also stated that preservice science teachers begin to explore the subject, dispel their misconceptions, get an accurate conceptual grasp, and complement this learning with their observations, they usually develop positive attitudes toward astronomy. Students with a positive attitude towards astronomy can stimulate their learning and study more diligently. That is, attitudes towards astronomy can be important for learning astronomy concepts and gaining more conceptual understanding (Nilsen & Angell, 2014).

### **5.5 Gender Differences in terms of Misconceptions about Astronomy Concepts and Attitude Towards Astronomy**

In this study, gender differences related to attitudes towards astronomy and misconceptions about astronomy concepts were investigated. In terms of attitudes towards astronomy, the only difference between males and females was the sub-factor of "being interested". The findings of the current study agree with Marusic and Hadzibegovic's (2018) study. The researchers found that there were no significant differences between male and female high school students' attitudes towards astronomy. In particular, the questionnaire that they used in their study included four sub-factors, which are interest, experience, skills, and career. Even though there was a difference in the sub-factor of "being interested" between males and females involved in the present study, Marusic and Hadzibegovic (2018) found no difference in this sub-factor between males and females. This could have occurred because of the disparities in the grade levels. In contrast to these studies, Dewitt and Bultitude (2018) did a study where the number of participants was about 8000 students across 11 European countries, and the students' ages were between 9 and 16 years old. They found that male students had more positive attitudes towards astronomy than female students. The most common sociological causes for female students' lower positive attitudes toward science than male students are distinct

cultural expectations imposed by parents, instructors, and peers, as well as different science experiences at school and in private life (She, 1998).

For 6th grade students, there was a correlation between misconceptions and gender, while for 7th grade students, there was no correlation between misconceptions and gender. The difference between gender and misconceptions in 6th grade may be due to the interests or attitudes of these particular students towards astronomy. In terms of correct responses about astronomy, there was no significant difference between genders in terms of correct responses for both 6th and 7th grade students. The results obtained from this study revealed different findings than those of a recent study by Türkmen (2015). His findings indicated that female students' correct responses to questions about astronomy tended to be better than male students. This could be due to the fact that female students had a more positive attitude towards astronomy or interest in astronomy than male students, according to that study. The current study provides a better understanding of gender differences in understanding and misconceptions about astronomy and attitudes toward astronomy.

#### **5.6 Interest in Astronomy in terms of Misconceptions about Astronomy Concepts and Attitude Towards Astronomy**

Students' interests in science are vital for learning science, and students' attitudes are one of the most essential aspects in learning science. In 6th and 7th grade students, there is a relationship between attitudes towards science and an interest in astronomy. Sjøberg and Schreiner (2010) found that when males and females are interested in science, they normally express positive attitudes towards science.

For the 6th grade students, there was no significant correlation between students who are interested in astronomy and students who are not interested in astronomy in terms of misconceptions. However, there was a significant correlation between students who are interested in astronomy and students who are not interested in astronomy in terms of correct responses. For 7th grade students, there was a significant correlation

between students who are interested in astronomy and students who are not interested in astronomy in terms of misconceptions. The study's findings were similar to those of Ogunkola and Fayombo (2009). They found that there was a link between students' science achievement and their interest in science. They claim that students who have a strong interest in science are more likely to acquire good study habits and achieve high academic achievement in science. There is also a link between interest and effort, according to Bulunuz and Jarret (2009). People's interest in any subject determines how much work they will put into it. Because of its perceived value, an interested person is engaged and captivated by an activity. As a result, students that are interested in astronomy will go to greater lengths to study astronomy concepts.

### **5.7 Future Occupation in terms of Misconceptions about Astronomy Concepts and Attitude Towards Astronomy**

In 6th and 7th grade students, there was a relationship between attitudes towards astronomy and future occupations. The outcomes of this research parallel those found by Razali, Talib, Abd Manaf, and Hassan (2018), according to whom there was a relationship between attitude towards STEM subjects and STEM career interest. The results from the current study are also supported by the outcome of the study conducted by Suprpto (2016), who discovered that students' attitudes towards STEM have a direct impact on pursuing STEM careers. For 6th grade students, there was no significant correlation between students who chose occupations related to math, science, and social science in terms of misconceptions and correct responses about astronomy concepts. For 7th grade students, although there was no significant correlation between students who either chose an interest in math, science, or social studies in terms of misconception scores, there was a significant correlation between students' interest in subjects in terms of correct response scores. Similar findings were also reported in a study conducted by Park, Khan, and Petrina (2009). There

appears to be a relationship between student achievement in science and their aspirations for careers in the field.

## **5.8 Implication of the Study**

As this study shows, identifying students' astronomy misconceptions can help instructors and educational policymakers enhance the quality of science teaching and learning. To illustrate, teachers can benefit from the results of the study to come up with new lesson plans addressing these common misconceptions. They can organize learning experiences and activities to remediate these in particular. For example, one of the misconceptions found in this study is that Mercury is the hottest planet in the solar system. Teachers would be made aware of this misconception, and thus should be able to focus on explaining to their students in detail why Mercury is not the hottest planet. As mentioned previously, astronomy concepts learned in 5th grade are the basis for other understanding in other levels. Hence, teachers should ensure their students' maximum understanding of the concepts covered in earth and universe units early in the 5th grade. For that reason, teachers should look for 3D materials, simulations and videos covering the concepts of the Earth, Sun, and Moon as well as their orbits. In addition, teachers should underline that in comparison to the plane of the Earth's orbit around the Sun, the plane of the Moon's orbit around the Earth is tilted by around 5 degrees. This situation creates preliminary information for the concept of solar and lunar eclipses, which is covered in detail in the 6th grade. Of particular interest is the use of 3D models and simulations while teaching about the phases of the moon. Using 3D models enables students to understand this concept easier. When the concept of phases of the Moon is covered by using 2D models, students may be confused as to the exact cause of the phases or eclipses.

Moreover, this data can be useful for educational policymakers as it will assist them in revising the curriculum and ensuring that these misconceptions are also addressed in particular in the curriculum and in course textbooks. The study shows that 6th grade students as well as 7th grade students had typically the same misconceptions

about astronomy concepts regarding the phases of the moon, solar and lunar eclipses, and the temperature of the planets. It might be difficult to address these misconceptions, and they can be resistant to change since they were first developed in the 5th grade and continued into the 6th and 7th grades. As a result, it is critical for teachers and policymakers to be better prepared to deal with these concepts at the earliest grade levels. Moreover, since teachers and preservice teachers can also have misconceptions about astronomy concepts, teacher education programs should include lessons discussing these misconceptions and how to eliminate them. To establish this, the Ministry of Education should organize training or seminars concerning misconceptions for preservice teachers, and should require instructors to attend these seminars to develop their knowledge in this field.

The correlation between misconceptions about astronomy and attitudes toward astronomy examined in this study can reveal important information regarding the strength and direction of the relationships between them. Teachers can consider students' views and inspire them to take a more positive approach to astronomy. Moreover, the educators of teachers can make preservice teachers raise their awareness of these relationships. Finally, the current study demonstrates to policymakers the relationships between students' misconceptions about astronomy and their attitude towards astronomy. Therefore, they can keep these relationships in mind during the development of the curriculum process. Moreover, one of the key goals of the Turkish science curriculum is to increase students' understanding of scientific careers and entrepreneurial applications in science (MONE, 2018). Teachers can aid students in developing positive attitudes toward astronomy and increasing their interest in the subject, which will help them pick a future career in science.

## **5.9 Recommendations of Future Research**

Based on the findings of this and previous studies, the following recommendations are offered. This study should be replicated for 8th grade levels to investigate

whether these identified misconceptions are also present in 8th grade. In addition, this study should be replicated for schools in different districts of Ankara. This provides more accurate results and the chance to compare schools in different districts of Ankara in line with these results. Moreover, to understand the reasons for the misconceptions, more qualitative studies can be done. Finally, experimental studies can be done to examine which methods would be effective in remediating these misconceptions.

### **5.10 Limitation**

The following limitations were identified in this study:

1. The study was limited to six middle schools in Ankara/ Çankaya.
2. The study was limited by its reliance on self-reported data on participants' responses.
3. The study was limited to 6th and 7th grade middle school students.
4. The study was limited to astronomy concepts that include the structure of the Sun, the features of the planets, the Moon, the phases of the Moon, and meteors.
5. The study was limited to qualitative research methods.

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## APPENDICES

### APPENDIX A

#### A. Demographic Information Questionnaires

Sevgili Öğrenciler,

Bu çalışmanın amacı sizlerin astronomi ile ilgili kavram yanlışlarını tespit etmek ve astronomi kavram yanlışları ile birlikte astronomiye karşı tutumlarınız arasındaki ilişkiyi incelemektir. Bu çalışma üç bölüme ayrılmıştır. Birinci bölümde kişisel bilgilerinizin yer aldığı “Demografik Bilgi Formu” ikinci bölümde “Astronomi Tutum Ölçeği” ve üçüncü bölümde ise “Astronomi Kavram Yanılgısı Testi” bulunmaktadır. Bu bir **simav** değildir. Bu bir bilimsel çalışmadır. Araştırmadan elde edilecek sonuçlar yalnızca bilimsel amaçla kullanılacaktır. Ölçeklerde yer alan bilgiler gizli tutulacaktır. Sizin bu çalışmaya katılımınız bizim için çok değerli. Gerekli ilgiyi gösterdiğiniz için teşekkür ederiz.

##### Bölüm: Demografik Bilgiler

Yaş :

Cinsiyet :  Kız  Erkek

Sınıf :  6.sınıf  7.sınıf

Fen konularını takip ettiğim yerler :  Dergiler  Okul kitapları  Diğer.....

Fen konularını aşağıdaki hangi **medya ortamlarında** hangi **sıklıkla** takip edersiniz? (Size uygun olan seçeneğin altındaki parantez içine **X** işareti koyunuz.)

| Medya Ortamları         | Sıklıkla | Nadiren | Hiç |
|-------------------------|----------|---------|-----|
| Facebook                | ( )      | ( )     | ( ) |
| Twitter                 | ( )      | ( )     | ( ) |
| Youtube                 | ( )      | ( )     | ( ) |
| Televizyon              | ( )      | ( )     | ( ) |
| Podcast                 | ( )      | ( )     | ( ) |
| Gazete                  | ( )      | ( )     | ( ) |
| Popüler Bilim Dergileri | ( )      | ( )     | ( ) |
| İnternet Siteleri       | ( )      | ( )     | ( ) |

Dünya ve uzay ile ilgili konular ilginizi çeker mi?

Evet  Hayır

Uzay ile ilgili bilgileri hangi **kaynaklardan** hangi **sıklıkla** takip edersin? Size uygun olan seçeneğin altındaki parantez içine **X** işareti koyunuz.)

| Kaynaklar                  | Sıklıkla | Nadiren | Hiç |
|----------------------------|----------|---------|-----|
| Uzay Ajanslarının Siteleri | ( )      | ( )     | ( ) |
| NASA                       | ( )      | ( )     | ( ) |
| Facebook                   | ( )      | ( )     | ( ) |
| Twitter                    | ( )      | ( )     | ( ) |
| Youtube                    | ( )      | ( )     | ( ) |
| Televizyon                 | ( )      | ( )     | ( ) |
| Podcast                    | ( )      | ( )     | ( ) |
| Gazete                     | ( )      | ( )     | ( ) |
| Popüler Bilim Dergileri    | ( )      | ( )     | ( ) |
| İnternet Siteleri          | ( )      | ( )     | ( ) |

Gökbilim ve Gökyüzü ile ilgili olarak yapılan herhangi bir etkinliğe katıldınız mı? (Gözlem şenliği, yarışma, konferans vs.)

EVET  HAYIR

Yanıtınız evet ise kısa bilgi veriniz.

Katıldığınız Etkinliğin Adı: 1) .....

2) .....

İleride tercih etmek istediğin meslek:

.....  
.....



## APPENDIX B

### B. Astronomy Attitude Scale

| 2. Bölüm: Astronomi Tutum Ölçeği   |                            |              |            |            |                          |
|--|----------------------------|--------------|------------|------------|--------------------------|
| <p>Sevgili Öğrenciler,</p> <p>Bu ölçek bir sınav değildir. Bilimsel bir çalışma için hazırlanmıştır. Bundan dolayı, astronomi konuları (Örneğin, Güneş, Gezegenler, Uydu, Uzay vb.) ile ilgili düşünceleri ifade eden cümlelerle ilgili olarak size en uygun bölümü işaretleyiniz. İfadelerin karşısında “kesinlikle katılmıyorum”, “katılmıyorum”, “kararsızım”, “katılıyorum” ve “kesinlikle katılıyorum” olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatlice okuduktan sonra size en uygun seçeneği işaretleyiniz. İşaretlediğiniz seçenek sizin duygu ve düşüncelerinizi yansıtacaktır, dolayısıyla doğru ya da yanlış cevap vermeniz söz konusu değildir.</p> |                            |              |            |            |                          |
| Adı-Soyadı:  | KESİNLİKLE<br>KATILMIYORUM | KATILMIYORUM | KARARSIZIM | KATILYORUM | KESİNLİKLE<br>KATILYORUM |
| 1. Astronomi sevdiğim bir alandır.   | 1                          | 2            | 3          | 4          | 5                        |
| 2. Astronomi dersi almaktan hoşlanırım.  | 1                          | 2            | 3          | 4          | 5                        |
| 3. Astronomi alanında iddialyım.   | 1                          | 2            | 3          | 4          | 5                        |
| 4. Astronomi dersini dinlerken canım çok sıkılır.  | 1                          | 2            | 3          | 4          | 5                        |
| 5. Astronomi konularını anlamaya çalışmak zaman kaybıdır.  | 1                          | 2            | 3          | 4          | 5                        |
| 6. Öğrendiğim astronomi konularını kısa bir süre sonra unuturum.   | 1                          | 2            | 3          | 4          | 5                        |
| 7. Sınıf arkadaşlarımla astronomi konularını konuşmaktan hoşlanmam.  | 1                          | 2            | 3          | 4          | 5                        |
| 8. Astronomi konularını deney yaparak öğrenmek isterim.  | 1                          | 2            | 3          | 4          | 5                        |
| 9. Astronomi son derece teknik bir alandır.  | 1                          | 2            | 3          | 4          | 5                        |
| 10. Astronomi bilimini öğrenebilirim.  | 1                          | 2            | 3          | 4          | 5                        |
| 11. Astronomi karmaşık bir alandır.  | 1                          | 2            | 3          | 4          | 5                        |
| 12. Astronomi önemsiz bir alandır.   | 1                          | 2            | 3          | 4          | 5                        |
| 13. Astronomi konularını uygulamalı olarak daha iyi anlarım.   | 1                          | 2            | 3          | 4          | 5                        |

|  |   |   |   |   |   |
|--|---|---|---|---|---|
| 14. Astronomi konularını modeller üzerinde daha iyi anlarım.                         | 1 | 2 | 3 | 4 | 5 |
| 15. Astronomi kavramlarını anlamak kolaydır.   | 1 | 2 | 3 | 4 | 5 |
| 16. Astronomi sınavlarında başarısız olacağım hissine kapılırım.                     | 1 | 2 | 3 | 4 | 5 |
| 17. Astronomi dersinde kendimi stres altında hissederim.                             | 1 | 2 | 3 | 4 | 5 |
| 18. Astronomi ödevi yapmam gerektiğinde kendimi güvensiz hissederim.                 | 1 | 2 | 3 | 4 | 5 |
| 19. Astronomi günlük yaşamın her aşamasında vardır.                                  | 1 | 2 | 3 | 4 | 5 |
| 20. Astronomiyi hayatım boyunca birçok yerde kullanacağıma inanırım.                 | 1 | 2 | 3 | 4 | 5 |
| 21. Astronomi alanındaki yeni gelişmeler ilgimi çeker.                               | 1 | 2 | 3 | 4 | 5 |
| 22. Astronomi ile ilgili güncel gelişmeleri takip ederim.                            | 1 | 2 | 3 | 4 | 5 |
| 23. Astronomi sayesinde çevremdeki olayları daha iyi gözlerim.                       | 1 | 2 | 3 | 4 | 5 |
| 24. Astronomi sayesinde doğa hakkında bilgilenirim.                                  | 1 | 2 | 3 | 4 | 5 |
| 25. Astronomi sayesinde bilimin hayatımdaki önemini kavrarım.                        | 1 | 2 | 3 | 4 | 5 |
| 26. Doğa olaylarını astronomi bilgilerimi kullanarak anlamaya çalışmak hoşuma gider. | 1 | 2 | 3 | 4 | 5 |
| 27. Astronomi konuları fene ilgimi artırır.  | 1 | 2 | 3 | 4 | 5 |

## APPENDIX C

### C. Misconceptions Test About Astronomy Concepts (MTAC)

#### ASTRONOMİ KAVRAMLARI İLE İLGİLİ KAVRAM YANILGISI TESTİ

##### SORU 1

I) Güneş yapısal olarak hangi tür bir gök cisimidir?

- A. Yıldız
- B. Gezegen
- C. Asteroit
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü kaya ve metallere oluşmuş bir gök cisimidir.
- B. Çünkü doğal ısı ve ışık kaynağıdır.
- C. Çünkü Güneş Sistemi içindeki gezegenlerden biri ve en büyüğüdür.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

## **SORU 2**

I) Aşağıdakilerden hangisi üzerine gelen ışığı yansıtır?

- A. Güneş
- B. Gezegen
- C. Yıldız
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü doğal ışık kaynakları olmadıkları için yıldızlardan aldığı ışığı yansıtır.
- B. Çünkü meteor olduğu için Güneş'ten aldığı ışığı yansıtır.
- C. Çünkü bir asteroit olduğu için yıldızlardan aldığı ışığı yansıtır.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

### **SORU 3**

I) En sıcak gezegen aşağıdakilerden hangisidir?

- A. Merkür
- B. Venüs
- C. Güneş
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü, yoğun atmosferinde bulunan karbon gazları ısıyı tuttuğu için en sıcak gezegendir.
- B. Çünkü, Güneş Sistemi'nde diğer gezegenlere ısı veren en sıcak gezegendir.
- C. Çünkü, Güneş'e en daha yakın gezegen olduğu için en sıcak bir gezegendir.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

#### **SORU 4**

I) Dünya'dan Ay'ın hep aynı kraterlerinin görüntülerini görmemizin ve diğer taraflarındaki kraterlerini göremememizin nedeni nedir?



- A. Ay'ın Güneş etrafında dolanması
- B. Ay'ın kendi etrafında dönmesi ve Dünya etrafındaki hareketi
- C. Ay'ın hareket etmemesi
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü Ay hem kendi etrafındaki dönüşünü hem de Dünya etrafındaki dolanmasını aynı sürede tamamlar.
- B. Çünkü, yalnızca Dünya kendi eksenini etrafında döner.
- C. Çünkü, Ay ve Dünya Güneş etrafında aynı hızla dolanır.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A) Eminim
- B) Emin değilim

## **SORU 5**

I) Ay'ın hareketleri ile ilgili aşağıda verilen bilgilerden hangisi **yanlıştır**?

- A. Ay kendi ekseni etrafında dönmez.
- B. Ay kendi ekseni etrafında döner.
- C. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

II) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerde hangisidir?

- A. Çünkü uzaydaki bütün gök cisimleri kendi etrafında döner.
- B. Çünkü Ay Dünya'nın uydusu olduğu için Dünya'nın etrafında dolanır.
- C. Çünkü Ay'ın hep aynı yüzü görülür.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

## SORU 6

I) Yandaki şekilde farklı günlerde gökyüzünde gözlemlenen Ay'ın farklı evreleri bir arada gösterilmektedir. Ay'ın farklı günlerde farklı evrelerde görünmesinin nedeni nedir?



- A. Ay'ın Dünya etrafında dolanması
- B. Ay'ın hareket etmemesi
- C. Ay'ın Dünya'nın gölgesine girmesi
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü, Ay, Dünya etrafında dolanırken farklı açılardan Güneş ışığını alır.
- B. Çünkü, Ay, Dünya'nın etrafında dolanırken Dünya'nın gölgesine girer.
- C. Çünkü, Dünya Güneş etrafında dolanırken Ay farklı açılardan Güneş ışığı alır.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim



## **SORU 7**

I) Ay tutulması ve Güneş tutulması her ay gerçekleşmez. Bunun nedeni aşağıdakilerden hangisidir?

- A. Dünya ve Ay'ın dolanma hızlarının birbirinden farklı olması
- B. Dünya ve Ay'ın dönme düzlemleri arasında yaklaşık  $5^\circ$  lik fark olması
- C. Ay'ın hareket etmemesi
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Ay, Dünya etrafında 1 ayda dolanırken, Dünya Güneş etrafında 1 yılda dolanır. Dolayısıyla Ay, Dünya ve Güneş her ay aynı doğrultuda olmaz.
- B. Ay kendi eksenini etrafında dönmez. Dolayısıyla, Ay, Dünya ve Güneş her ay aynı doğrultuda olmaz.
- C. Tutulmaların gerçekleşmesi için Dünya'nın yörünge düzlemi ile Ay'ın yörünge düzleminin her ay çakışması gerekir. Bu durum her ay gerçekleşmez.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Önceki sorulara verdiğiniz yanıtlardan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

## **SORU 8**

I) Yıldız kayması nedir?

- A. Yıldızların yanarak sönmesidir.
- B. Atmosferden geçerken yanan meteorlardır.
- C. Gökyüzünde görülen kuyruklu yıldızlardır.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü, meteorlar atmosferden geçerken sürtünme sonucu yanar, ışık saçar.
- B. Çünkü, kuyruklu yıldızların Dünya atmosferinden geçerken kuyruklarının saçtığı ışık daha net görünür.
- C. Çünkü, yıldızlar ömrü biterken yanarlar ve bu yanma sonucunda ışık saçar.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Önceki sorulara verdiğiniz yanıtlardan ne kadar eminsiniz?

- C. Eminim
- D. Emin değilim

## **SORU 9**

D) Meteorların atmosfere girince ışık saçarak ilerlemesinin nedeni aşağıdakilerden hangisinde verilmiştir?

- A. Yıldız olduğu için atmosferde ışık saçması
- B. Atmosfere girince hava ile sürtünmesinden dolayı
- C. Güneş ışınlarını yansıtması
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtın nedeni aşağıdakilerden hangisidir?

- A. Meteorlar ışık kaynağı değildir. Ancak Dünya'ya doğru yaklaşırken Güneş'ten aldığı ışığı yansıtır.
- B. Meteorlar atmosferde yüksek hızla ilerlerken hava ile sürtünmesinden dolayı, ani sıcaklık yükselmesi sonucu yanar ve ışık saçar.
- C. Uzayda yıldızlar ışık saçabilirler. Meteor atmosferden geçerken yıldız gibi davranır.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıttan ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

## **SORU 10**

I) Güneş sistemindeki gezegenler için aşağıdakilerden hangisi doğrudur?

- A. Tüm gezegenler karasal yapıya (katı yüzeye) sahiptir.
- B. Tüm gezegenler karasal yapıya (katı yüzeye) sahip değildir.
- C. Yalnızca Merkür gazsal yapıya sahiptir.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

II) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

III) Birinci aşamada verdiğiniz yanıtta uygun açıklama aşağıdakilerden hangisidir?

- A. Çünkü, Merkür en sıcak gezegen olduğu için gazlardan oluşur.
- B. Çünkü, iç ve dış gezegenler kayalardan ve metallere oluşurlar.
- C. Çünkü, dış gezegenler sadece gazlardan oluşur.
- D. Hiçbiri (SİZCE NE OLMALI?.....)

IV) Bir önceki soruya verdiğiniz yanıtta ne kadar eminsiniz?

- A. Eminim
- B. Emin değilim

## APPENDIX D

### D. Permission to Use the Attitude Astronomy Scale

**Konu:** Re: Astronomi tutum ölçeği  
**Gönderen:** Cumhuriyet Türk <cumhuriyet.turk@samsun.edu.tr>  
**Tarih:** 31 Ekim 2019, Perşembe, 7:45 pm  
**Alınan:** "Ayşe Yıldız" <ayse.yildiz@metu.edu.tr>  
**Öncelik:** Normal  
**Seçenekler:** [Tüm Başlıkları Göster](#) | [Yazdırılabilir Şekilde Göster](#) | [Bunu dosya olarak indir](#) | [HTML olarak göster](#)

Merhaba  
Tabiki kullanabilirsiniz.  
İyi çalışmalar

Doç. Dr. Cumhuriyet TÜRK  
Samsun Üniversitesi  
İletişim Tasarımı ve Yönetimi Bölümü  
Tel: 03623130055 / Dahili: 1025  
E-mail: cumhuriyet.turk(at)samsun.edu.tr  
cumhuriyetkk(at)gmail.com  
Web: www.cumhuriyetturk.com

Cumhuriyet TÜRK  
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cumhuriyetkk(at)gmail.com  
Web: www.cumhuriyetturk.com

> Ayşe Yıldız <ayse.yildiz@metu.edu.tr> şunları yazdı (31 Eki 2019 19:19):  
>  
> Cumhuriyet Hocam merhaba,  
> Ben Ayşe Yıldız. Orta Doğu Teknik Üniversitesinde Fen eğitimi alanında  
> yüksek lisans yapıyorum. Tez konumda, öğrencilerin astronomiye karşı  
> tutumlarının ,öğrencilerdeki astronomi ile ilgili kavram yanlışlarının  
> ilişkisine bakacağım . Araştırma yaparken, sizin 2015 yılında yapılan bir  
> çalışmanız (Astronomy Attitude Scale: Development, Validity and  
> Reliability ) okudum.Bu çalışmada kullandığınız Astronomi Tutum Ölçeğinin  
> türkçesini benimle paylaşmıştınız. Bu ölçeği tezimde kullanabilir miyim ?  
>  
> Şimdiden teşekkür ederim , iyi çalışmalar  
> Saygılarımla,  
> Ayşe Yıldız

## APPENDIX E

### E. Permission to Use the Tests

**Konu:** Re: TEZ İÇİN  
**Gönderen:** özlem göncü <ozgoncu@gmail.com>  
**Tarih:** 1 Kasım 2019, Cuma, 10:57 am  
**Alıcı:** "Ayşe Yıldız" <ayse.yildiz@metu.edu.tr>  
**Öncelik:** Normal  
**Seçenekler:** [Tüm Başlıklar Göster](#) | [Yazdırılabilir Şekilde Göster](#) | [Bunu dosya olarak indir](#) | [HTML olarak göster](#)

Tabii hocam kullanabilirsiniz

31 Eki 2019 Per 19:21 tarihinde Ayşe Yıldız <[ayse.yildiz@metu.edu.tr](mailto:ayse.yildiz@metu.edu.tr)> şunu yazdı:

```
> Hocam tekrardan merhaba,  
> Acaba testleri tezimde kullanabilir miyim?  
>  
> Çok teşekkür ederim,  
> Saygılarımla,  
> Ayşe  
>  
>  
>> Çok teşekkür ederim Özlem Hocam.  
>>  
>> Saygılarımla ,  
>>  
>> Ayşe  
>>  
>>  
>> Merhabalar Ayşe hocam.  
>> Testler ekte. Çalışmalarınızda kolaylıklar dilerim.  
>>  
>> 27 Nis 2018 Cum 19:47 tarihinde Ayşe Yıldız <ayse.yildiz@metu.edu.tr>  
>> şunu  
>> yazdı:  
>>> Özlem Hocam merhaba,  
>>>  
>>> Ben Ayşe Yıldız. Orta Doğu Teknik Üniversitende den eğitimi alanında  
>>> yüksek lisans yapıyorum.2013 yılında Fikret Hocam'la beraber yapmış  
>>> olduğunuz tezinizi inceledim. Çalışmada uyguladığınız 3 aşamalı kavram  
>>> yanlışlığı tespiti için kullandığınız testi (özellikle 5.sınıflara  
>>> uyguladığınızı) paylaşabilir misiniz?  
>>>  
>>> Şimdiden çok teşekkür ederim,  
>>> İyi akşamlar ,  
>>> Saygılarımla  
>>>
```

## APPENDIX F

### F. Permission to Use the Test

[Arama Sonuçları](#) | [Okunmamış](#) | [Sil](#)

**Konu:** Re: Tez için ölçek  
**Gönderen:** Hüseyin Küçüközer <hkucuk@balikesir.edu.tr>  
**Tarih:** 30 Nisan 2018, Pazartesi, 4:07 pm  
**Alıcı:** "Ayşe Yıldız" <ayse.yildiz@metu.edu.tr>  
**Öncelik:** Normal  
**Seçenekler:** [Tüm Başlıkları Göster](#) | [Yazdırılabilir Şekilde Göster](#) | [Bunu dosya olarak indir](#)

Merhaba,  
İstedığınız Astronomi Kavramları Anketi ekte. Kolay gelsin, iyi çalışmalar.

----- Orijinal Mesaj -----  
Kimden: "Ayşe Yıldız" <ayse.yildiz@metu.edu.tr>  
Kime: [hkucuk@balikesir.edu.tr](mailto:hkucuk@balikesir.edu.tr)  
Gönderilenler: 27 Nisan Cuma 2018 19:53:17  
Konu: Tez için ölçek

Hüseyin Hocam merhaba,

Ben Ayşe Yıldız. Orta Doğu Teknik Üniversitesinde Fen eğitimi alanında yüksek lisans yapıyorum. Tez konumda öğrencilerin astronomiye karşı tutumlarının, epistemolojik inançlarının ve astronomi kavram yanılgılarının arasındaki ilişkiye bakacağım. Sizin konuyla ilgili yaptığınız çalışmaları inceledim " Prospective science teachers' conceptions about astronomical subject " ve "İlköğretim matematik öğretmeni adaylarının bazı astronomi kavramlarına ilişkin fikirlerine öğretimin etkileri"... Matematik öğretmenleri ile yaptığınız çalışmada kullandığınız "Astronomi Kavrama Anketini" benimle paylaşabilir misiniz?

Şimdiden çok teşekkür ederim,

Saygılarımla,  
Ayşe YILDIZ

## APPENDIX G

### G. Permission the Ethics Committee of The Middle East Technical University

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ  
APPLIED ETHICS RESEARCH CENTER



DÜMLÜPINAR BULVARI 06060  
ÇANKAYA ANKARA/TÜRKİYE  
T: +90 312 210 22 91  
F: +90 312 210 79 59  
iesan@metu.edu.tr  
Sayı: 28620816/443

21 KASIM 2019

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Özgül Yılmaz TÜZÜN

Danışmanlığınızı yaptığınız Aysa YILDIZ'ın "Beşinci, Altıncı ve Yedinci Sınıf Öğrencilerinin Astronomi ile İlgili Kavram Yanılgıları, Astronomiye Karşı Tutumları ve Epistemolojik İnançları Arasındaki İlişkilerin Araştırılması" başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülmüş ve 423 ODTU 2019 protokol numarası ile onaylanmıştır.

Saygılarımızla bilgilerinize sunarız.

Prof. Dr. Tülin GENÇOZ

Başkan

Prof. Dr. Tolga CAN  
Üye

Doç.Dr. Pınar KAYGAN  
Üye

Dr. Öğr. Üyesi Ali Emre TURGUT  
Üye

Dr. Öğr. Üyesi Şerife SEVİNÇ  
Üye

Dr. Öğr. Üyesi Müge GÜNDÜZ  
Üye

Dr. Öğr. Üyesi Süreyya Özcan KABASAKAL  
Üye



## APPENDIX H

### H. Permission from the Ministry of National Education



T.C.  
ANKARA VALİLİĞİ  
Milli Eğitim Müdürlüğü

Sayı : 14588481-605.99-E.211855  
Konu : Araştırma İzni

03.01.2020

ORTA DOĞU TEKNİK ÜNİVERSİTESİNE  
(Öğrenci İşleri Daire Başkanlığına)

İlgi : a)MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2017/25 nolu Genelgesi.  
b)11.12.2019 tarihli ve 170 sayılı yazınız.

Üniversiteniz Matematik Ve Fen Bilimleri Anabilim Dalı Fen Bilimleri Eğitim Programı yüksek lisans öğrencisi Ayşe YILDIZ'ın "**Beşinci, Altıncı ve Yedinci Sınıf Öğrencilerinin Astronomi ile İlgili Kavram Yanılguları, Astronomiye Karşı Tutumları ve Epistemolojik İnançları Arasındaki İlişkilerin Araştırması**" konulu çalışması kapsamında İlimiz Çankaya İlçesine bağlı, ekli listede belirtilen okullarda uygulama talebi ilgi (b) Genelge çerçevesinde incelenmiştir.

Yapılan inceleme sonucunda, söz konusu araştırmanın Müdürlüğümüzde muhafaza edilen ölçme araçlarını; Türkiye Cumhuriyeti Anayasası, Milli Eğitim Temel Kanunu ile Türk Milli Eğitiminin genel amaçlarına uygun olarak, ilgili yasal düzenlemelerde belirtilen ilke, esas ve amaçlara aykırılık teşkil etmeyecek, eğitim-öğretim faaliyetlerini aksatmayacak şekilde okul ve kurum yöneticilerinin sorumluluğunda gönüllülük esasına göre uygulanması Müdürlüğümüzce uygun görülmüştür.

Bilgilerinizi ve gereğini rica ederim.

Turan AKPINAR  
Vali a.  
Milli Eğitim Müdürü

Dağıtım:  
Gereği:  
Orta Doğu Teknik Üniversitesi

Bilgi:  
Çankaya İlçe MEM

Adres:  
Elektronik Ad:  
e-posta:

Bilgi için:  
Tel: 0 ( ) \_\_\_\_\_  
Faks: 0 ( ) \_\_\_\_\_

Bu belge gıvencik elektronik imza ile imzalanmıştır. <https://evrnlisayga.meb.gov.tr> adresinden 2405-90c8-3a41-ba7b-f70b kodu ile teyit edilebilir.