Journal of Turkish Science Education, 2022, *19*(4), 1135-1154.
DOI no: 10.36681/tused.2022.166


# Examining 5th Grade Students' Mental Models of Shadow, Solar Eclipse and Lunar Eclipse through Drawings: A Case Study

Emine Akkaş Baysal[1], İjlal Ocak[2], İlkay Aydoğmuş[3]

[1] *Sandıklı School of Applied Sciences, Afyon Kocatepe University, Türkiye, akkasemine85@hotmail.com, ORCID ID: 0000-0002-5711-0847*
[2] *Faculty of Education, Afyon Kocatepe University, Türkiye, ORCID ID: 0000-0001-6976-5747*
[3]*Pusula Schools, Türkiye, ORCID ID: 0000-0002-7523-3381*

**ABSTRACT**
This study aimed to elucidate the perceptions and mental models of 5th-grade secondary school pupils about shadows, solar eclipses and lunar eclipses through drawings. A total of 443 pupils studying at public schools in Afyonkarahisar participated in the study. It was conducted as a case study, one of the qualitative research designs. As a data collection tool, three open-ended questions developed by the researchers were used. The pupils drew pictures after reading these questions. The obtained data were analysed by content analysis. It was determined that the pupils had incomplete information about the subject and their perceptions of shadow, solar and lunar eclipses were mostly wrong. It was moreover observed that the pupils had difficulty drawing and writing something they had learned. This situation is considered extremely important in terms of activities that can be designed to overcome students' deficiencies.

**RESEARCH ARTICLE**

**ARTICLE INFORMATION**
Received:
11.03.2022
Accepted:
29.09.2022

**KEYWORDS:**
Shadow, solar eclipse, lunar eclipse, drawing, science course.

**To cite this article:** Akkaş Baysal, E., Ocak, İ. & Aydoğmuş, İ. (2022). Examining 5th grade students' mental models of shadow, solar eclipse and lunar eclipse through drawings: a case study. *Journal of Turkish Science Education, 19*(4), 1135-1154.

## Introduction

Primary and secondary educations are essential stages that form the basis of other educational processes in shaping students' futures. From this point of view, quality of education has an essential function in raising children (Aykaç, 2012). Teaching in contexts where various disciplines take place, such as Science, includes 21st-century skills such as critical, analytical and creative thinking. Within the scope of Science, it is aimed that the pupils acquire science and technology literacy and thereby become apply to apply science to real-life problems (Taşdemir & Demirbaş, 2010).

The vision of science curriculum is to enable all learners to become science literate. Science literacy is a combination of science-related skills, attitudes, values, understanding and knowledge, which are necessary to develop their critical thinking, problem-solving, and decision-making skills, to become lifelong learners and to maintain a sense of curiosity about their environment and the world (MEB, 2013). Pupils who acquire these skills are willing to do research, identify problems, generate hypotheses and design ways to solve the given problems and contribute to developing scientific process and critical thinking skills (Atasoy et al., 2007). Science literate people are successful in understanding nature, events in nature and the relationships between them (Kara et al., 2009). School

learners are trained to examine the circumstances encountered in daily life in terms of cause-effect relationships, and to establish logical connections between events (Çepni et al., 2003; Kara et al., 2009).

**Literature Review**

Getting to know the Earth we live in and examining the interactions of the Earth with the celestial bodies around it are among the subjects that people are most curious about. According to Bailey and others (2004), astronomy is the oldest known Science and has attracted the attention of people of all age groups since ancient times (as cited in Öztürk & Uçar, 2012). The results of a field study carried out by The Scientific and Technological Research Council of Turkiye (TUBITAK) in recent years to measure the science literacy of Turkish youth reveal that one of the subjects that most attracted their attention is astronomy (MEB, 2013). Astronomy, which is one of the most comprehensive and oldest branches of Science, examines the positions of celestial bodies, their movements, their distances from each other, and their structures in terms of physics and chemistry (Kırbıyık et al., 2007). Although astronomy is an old science, it has entered the classroom after many years. Studies on astronomy education have gained importance in European countries since 1990 as well as in Turkiye in recent years (Demirel & Aslan, 2014; Küçüközer et al., 2010; MEB, 2010; Öztürk & Uçar, 2012). Many celestial events such as solar and lunar eclipses, stellar rains, meteorite falling, comet appearance in the Science course arouse students' curiosity and attract their attention (MEB, 2010).

Hançer (2007) states that school learners have many misconceptions about science subjects and resist to eliminating these. Research shows that pupils have misconceptions about astronomy. For example, Taşcan and Ünal (2013) investigated pupils' misconceptions about solar and lunar eclipses. They falsely believed that the object visible on the Sun during the eclipse is the Earth. In another study regarding the lunar eclipse, pupils asserted that the Sun enters between the Earth and the Moon, that the Moon disappears behind the clouds and then reappears, and that a planet or star comes between the Moon and the Earth. The same pupils confused the lunar eclipse with moon phases and solar eclipses (Küçüközer et al., 2010).

People reflect on what is going on around them and perceive them in many different ways according to their age and life experience, education, values and attitudes, etc. They reveal their perceptions through speaking, writing, singing, painting, or taking actual actions. One of the actions children resort to concretely present their perceptions of their environment is drawing (Malchiodi, 2005, as cited in Yılmaz & Güven, 2015). Art has a special place in the richness of children's mental images. Drawing pictures has an important place in a child's self-definition, self-perception, and description of phenomena and events (Aykaç, 2012). According to Okaylı (2015), children's drawings are essential reflections of a child's way of thinking. Arıcı (2006) describes painting as a stronger means of expression and reflection than words. Drawing is used as a modelling exercise to provide symbolic support for displaying inner feelings and reflecting relationships (Solomon & George, 1999, as cited in Aykaç, 2012). From this point of view, studies on children's drawing are used as a diagnostic tool by psychologists. Children's drawings show how children perceive themselves and the outside world, their environment, and human relations. They tell their thoughts, learnings, sorrows, joys, and fears via drawings (Aykaç, 2012; Ersoy & Türkkan, 2010; Okaylı, 2015; Yavuzer, 2009). Drawing is like a language in which symbols and stereotypes are used (Aykaç, 2012).

Children make random simple doodles at a young age and then later add cognitive elements to them. With maturation and increasing mastery, children begin come to understand visual realities, including perspective (Güven, 2009). In the educational context, Atasoy (2002) defines drawing as an open technique that does not impose any restrictions on how the child will answer, other than minor limitations. Drawing allows teachers to see how learners reveal the quality of understanding (White & Gunstone, 1992, as cited in Aydın, 2011). Considering that the drawing is visually productive for the pupil in terms of permanence, it can be used both in the expression and evaluation of subject knowledge (Çeliker & Topal, 2011). Through the pictures they draw, pupils give information about themselves, reflect their mindsets, and their relationships with their peers and adults. In addition,

some studies have found that children's drawings are also related to their intelligence levels (Batı, 2012; Güven, 2009). For instance, when the children are asked to draw a person, they draw the person who reflects their last emotional state. If their mother bought them a shoe, they would draw their mother, and if their friend played the game they wanted, they would draw their friends (Okaylı, 2015).

Studies based on picture analysis have increased in the literature in recent years. Studies done in Turkey are mostly on the perception of "science". For example, a study conducted by Yörek (2007) tried to reveal how high school pupils conceptualise cell structure, including the general shape of the cell, organelles and their location in the cell through drawings. The pupils showed a preference for animal cells over plant cells in their cell drawings. When the organelle drawings and their locations in the cell were examined, it was seen that the pupils well understood the location of the nucleus, but the location of the cell membrane and cell wall were confused with each other. The lack of agreement among the pupils in the descriptions of other organelles suggests that they memorised the names of the organelles rather than comprehending their structure and function, and randomly placed them between the nucleus and the cell membrane. Another study conducted by Kaya and others (2008) determined the image of scientists of primary school pupils and how these ideas differ according to grade levels. In general, the children thought that a scientist is a bespectacled man in an apron working in a laboratory with a happy facial expression. Uzunkavak (2009) revealed in his study that the drawing method helped to reveal the basic knowledge and misconceptions of the pupils and confirmed the results of the written statements.

Ersoy and Türkkan's (2009) study was carried out to examine primary school pupils' perceptions of the Internet through their pictures. In another study conducted by Sadık and others (2014), pollution and deforestation were mostly perceived as environmental problems by children living in lower socioeconomic environments, while air pollution and decreasing species were mostly perceived by children living in higher socioeconomic environments. Ozone depletion, noise pollution, soil pollution and global warming are portrayed as environmental problems of which children's awareness is the lowest.

In their study, Çelikler and Topal (2011) aimed to determine the knowledge of primary school science teacher candidates about the carbon dioxide and water cycles. The study conducted by Balım and Ormancı (2012) aimed to determine the level of understanding of primary school pupils about the particulate nature of matter in terms of gender and grade level variables. In a study conducted by Aykaç (2012), a total of 1000 pupils enrolled in the 3rd to 8th grades were examined through their drawings on their perceptions of "teacher" and "learning process". Most of the children perceived teachers as "human" and a small part of them as entities such as Sun, flower, heart and book. The study conducted by Çelikler and Kara (2012) aimed to determine the knowledge of primary school science teacher candidates about the periodic table by drawing. Herdem and others (2014) examined the perceptions of 8th-grade pupils about technology through the cartoons they drew. It was observed that the pupils used personalisation analogies in the cartoons they drew. It was observed that the cartoons were associated with variables such as gender, socioeconomic and socio-cultural status.

Bülbül and others (2013) examined 8th-graders' perceptions of astronomy in their research. They concluded that the alternative concepts of the pupils about astronomy affected their perceptions of astronomy. Harman (2016) aimed to determine the mental models of secondary school pupils about solar and lunar eclipses. The mental models of the pupils were evaluated in four levels. In the study of Yılmaz and others (2015) aimed to determine the views of science teachers on pupil misconceptions of the Solar System and Space subjects. It was seen from the teachers' opinions that the pupils had misconceptions about astronomy concepts.

Lower secondary school education in Turkey starts at the fifth grade and ends at the eighth grade. The Science curriculum has spiral features - fifth grade science topics progress incrementally until the eighth grade. It will be difficult for a pupil who cannot assimilate a topic in the fifth grade level to add new information in the next levels. As mentioned above, there are some conceptual errors and lack of knowledge of students in some science issues (Hançer, 2007; Taşcan & Ünal, 2013). In

addition, there have been a limited number of studies aimed explicitly at determining learners' views on the concept of 'astronomical topics'. Accordingly, there are few studies on shadows and solar and lunar eclipses. This study will contribute to the field of science education in relation to astronomical topics. So, this study aimed to reveal what kind of misconceptions and lack of knowledge the pupils, especially at the fifth grade level, have on these astronomical topics. Revealing this will be illuminating for many teachers teaching this subject and will give them ideas about how lessons can better be conducted. The Research Question was: What do the 5th grade pupils know about shadow, solar and lunar eclipses?

## Methods

### Research Method

The case study methodology was used. The case study is an instance of a qualitative methodology. Qualitative research deals with how people perceive the world and what experiences they have in it; it focuses on understanding the meanings people make about various topics (Merriam, 2013). The critical point in qualitative research is to see the event, meaning, or process from the participant's perspective rather than the researcher's perspective (Kaynak & Temel, 2015). In qualitative research, data can be collected from sources such as observation notes, interview records, documents, pictures and other graphic presentations (drawings, tables, etc.) (Yıldırım & Şimşek, 2008). A case study is a methodological approach that involves an in-depth examination of a limited system using various data collection tools or methods to collect systematic information about how it works (Chmiliar, 2010). Children's drawings can be used as a powerful research tool in understanding, interpreting or evaluating certain educational phenomena. Data were accordingly collected through children's pictures to ascertain their perceptions of the concepts relating to the shadows and both solar and lunar eclipses.

### Sample

This study was carried out with 5$^{th}$ grade pupils enrolled at schools in the Turkish city of Afyonkarahisar in the 2021-2022 academic year. It involved 443 pupils between the ages of 10 and 11. Table 1 shows the distribution of the pupils sampled according to their gender and the region they live in.

**Table 1**

*Distribution of students by gender and region of residence*

| Demographic features | | Frequency | % |
|---|---|---|---|
| Gender | Female | 245 | 55 |
| | Male | 198 | 45 |
| Living area | City | 260 | 59 |
| | Town | 41 | 9 |
| | Country | 82 | 19 |
| | Village | 60 | 14 |
| Total | | 443 | 100 |

A total of 245 female (55%) and 198 male (45%) fifth-grade pupils participated in the study. Most of the participants (n=260; 59%) reside in the cities. The rate of the pupils living in the town (n=41; 9%) is lower than the pupils living in country (n=82; 19%) and villages (n=60; 14%). Pupils living in the cities have more social activity opportunities than pupils living in other settlements. These pupils can go to the movies in their spare time, visit science centers or fairs, or participate in

organizations where various events take place. Therefore, the probability of encountering events related to science is high. For this reason, the variable "living area" was also used in the study.

## Data Collection and Analysis

Pupils were given approximately 15-20 minutes to think about the following three situations: (1) how shadows are cast, (2) how the solar eclipse is cast and (3) how the lunar eclipse is cast. Next, they were asked to draw a picture of each of these three situations. They were also asked to write what they wanted to express under the pictures they drew. In the analysis of the data, both the pupils' drawings and comments were used to describe and interpret what the pupil wanted to express in their drawings (the content of the pictures). The researchers' also tried to interpret them by taking into account the figures used by the pupils, the objects they drew, the lines and colours they employed.

Content analysis was applied to the results. The basic process in content analysis is to organise similar data together within the framework of specific concepts and themes (Sadık et al., 2014). In this study, separate levels were created for each concept. In other words, there were five levels for shadow, five levels for solar eclipse, and five levels for lunar eclipse. In all concepts, at the first level, there were pictures explaining the concepts at the lowest level, while at the fifth level, which was the highest level, there were pictures explaining the concepts in the most accurate way. While describing and interpreting, each pupil's drawing is divided according to these levels. The pictures were examined by two experts and separated into the levels and then the coding was compared. The numbers of "consensus" and "disagreement" were determined in the comparison. Miles and Huberman's (1994) [(Consensus / Consensus + Disagreement)] formula was used in the reliability calculation. Inter-coder agreement was calculated as 0.96, 0.94 and 0.98 for shadows, solar eclipse and lunar eclipse respectively. The levels are given in Table 2.

**Table 2**

*Levels about shadow*

| Levels | Explanation |
|---|---|
| Level 1 | • There is no light source in the picture.<br>• There is no shadow in the picture.<br>• There is no drawing in the picture.<br>• There is no information under the picture. |
| Level 2 | • There is a light source in the picture.<br>• There is shadow in the picture.<br>• The drawing is incorrect in the picture.<br>• There is some information under the picture. |
| Level 3 | • There is a light source in the picture.<br>• There is shadow in the picture.<br>• The drawing is partially correct in the picture.<br>• Information is partially correct under the picture. |
| Level 4 | • There is a light source in the picture.<br>• There is shadow in the picture.<br>• The drawing is correct in the picture.<br>• There is missing information under the picture. |
| Level 5 | • There is a light source in the picture.<br>• There is shadow in the picture.<br>• Drawing is correct in the picture.<br>• Shadow is correct in the picture.<br>• There is information in the picture.<br>• The drawing is correct in the light of science curriculum objectives. |

Table 2 says that in a drawing accepted at Level 1, the light source is depicted; there is no shadow, no drawing, and no information about shadow under the picture. At Level 2, the light source is depicted and there is shadow, but the drawing about shadow is incorrect, there is some information

under the picture. At Level 3, the light source is depicted, there is shadow, the drawing and information about shadow are partially correct. At Level 4, there is a light source, shadow, the drawing is correct, but incomplete information is given. At Level 5, there is a light source, shadow, drawing is correct, the information given is correct. In addition, the drawing was carried out in the light of science curriculum objectives**.**

Table 3 shows the levels created to evaluate the drawings that will include information on solar and lunar eclipses and the criteria in these groups.

**Table 3**

*Levels on solar and lunar eclipses*

| Levels | Explanation |
|---|---|
| Level 1 | • There is no drawing in the picture.<br>• There is no information under the picture. |
| Level 2 | • There is drawing in the picture.<br>• There is information under the picture.<br>• The drawing is incorrect in the picture.<br>• Information is incorrect under the picture. |
| Level 3 | • The drawing is partially correct in the picture.<br>• Information is partially correct under the picture.<br>• The Sun, Earth, Moon are wrong in size. |
| Level 4 | • There is drawing in the picture.<br>• There is information under the picture.<br>• The drawing is correct in the picture.<br>• Information is correct under the picture.<br>• Drawings have no names. |
| Level 5 | • There is drawing in the picture.<br>• There is information under the picture.<br>• The drawing is correct in the picture.<br>• Information is correct under the picture.<br>• Drawings have names.<br>• The pupils draw the eclipse on the Earth. |

Table 3 presents the levels created to evaluate the information about the Solar and Lunar eclipses. The drawings at Level 1 don't have any drawings and information in the picture. Drawings and information are included in the drawings accepted at Level 2, but both are incorrect. In pictures accepted at Level 3, the drawing and information are partially correct. The sizes of the Sun, Earth and Moon are incorrect. Drawing and information are correct at level 4, but the names of the drawings are not included. At level 5, there is drawing and information; it is correct that the drawings' names are also available.

## Ethical Considerations

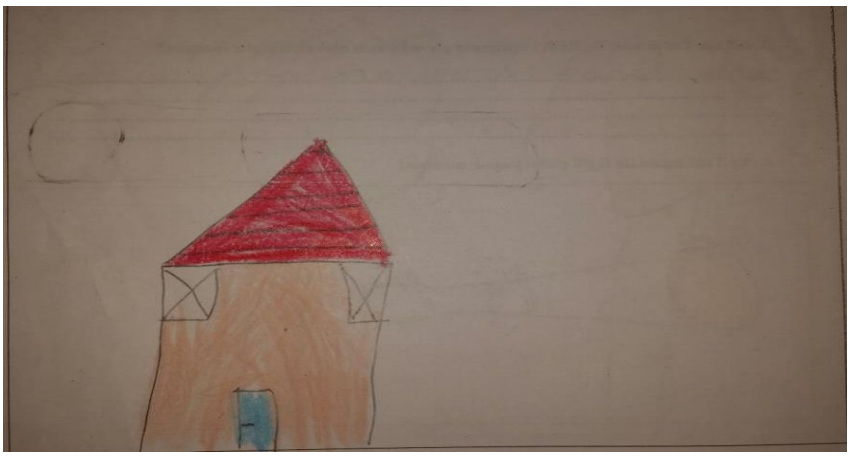
In this study, all the rules specified to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" were complied with. None of the actions specified under the title of "Actions Contrary to Scientific Research and Publication Ethics", which is the second part of the directive, were not carried out. In the study's data collection process, the concepts of "shadow, solar and lunar eclipse" in the 5th-grade science course units were used as key concepts, and the drawings were made within the framework of these concepts. The researcher informed the families of the application groups in which the drawings were made. Participants took part in the study on an entirely voluntary basis.

## Findings

This section has findings related to 443 drawings done by secondary school 5th-grade pupils. The perceptions of 5th-grade pupils were determined by analyzing the drawings about shadow, solar and lunar eclipses. This study revealed how much the pupils learned about shadow, solar and lunar eclipses and how they expressed the information they learned. Examples of the drawings made by the pupils, the frequencies and percentages are also included in this section. Figure 1 shows an example of a drawing on shadow and accepted at Level 1.

**Figure 1**

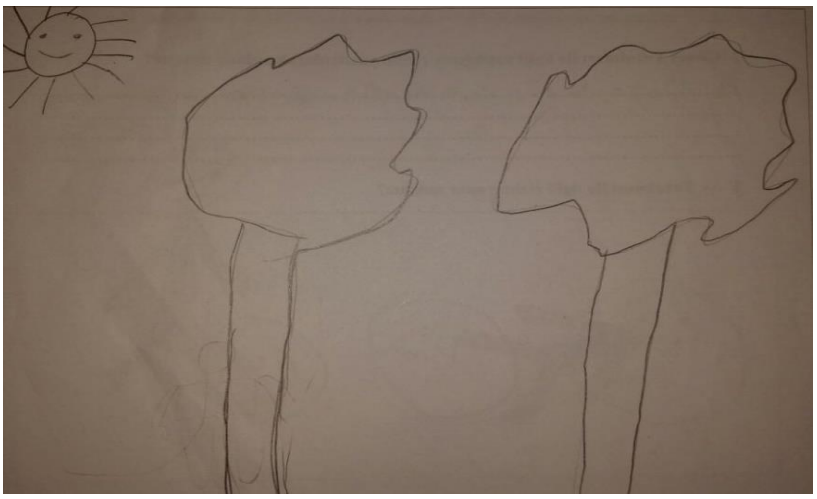
*Shadow Drawing and Information Example of Level 1*



At first, the pupil was told to draw a picture with a shadow. As seen in Figure 1, the pupil didn't draw a shadow. The pupil only drew a house and did not give any information about the shadow. In the drawing below (Figure 2), a shadow drawing is evaluated at Level 2.

**Figure 2**

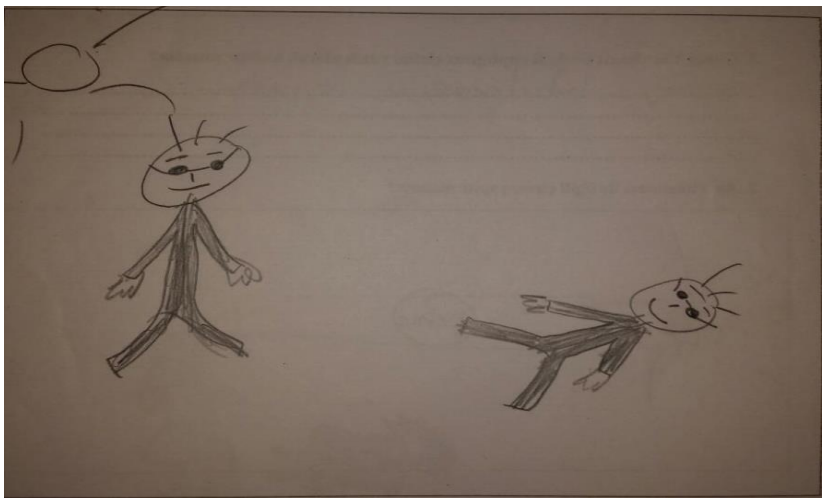
*Shadow Drawing and Information Example of Level 2*



The pupil was told to draw a picture with a shadow. This drawing provides incomplete information about the shadow. As seen in the drawing, the pupil didn't draw shadow. The pupil stated that "*The sun sends the rays of the sun to the tree, its shadow appears on the tree*". In the explanation, she expressed how the shadow was formed. Figure 3 shows a shadow drawing evaluated at Level 3.

**Figure 3**

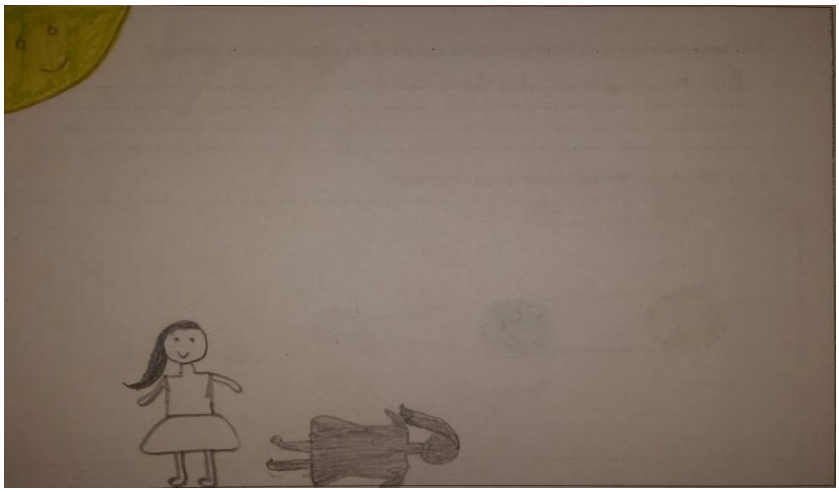
*Shadow Drawing and Information Example of Level 3*



The pupil was told to draw a picture with a shadow. As seen in Figure 3, the pupil drew the shadow and her drawing is partially correct. The shape of the shadow is drawn correctly in the drawing made by the student. In the information given under the drawing, "I drew the human shadow." He used the expression and did not mention how the shadow was formed. Therefore, it is partially accepted as true. Figure 4 shows a shadow drawing evaluated at Level 4.

**Figure 4**

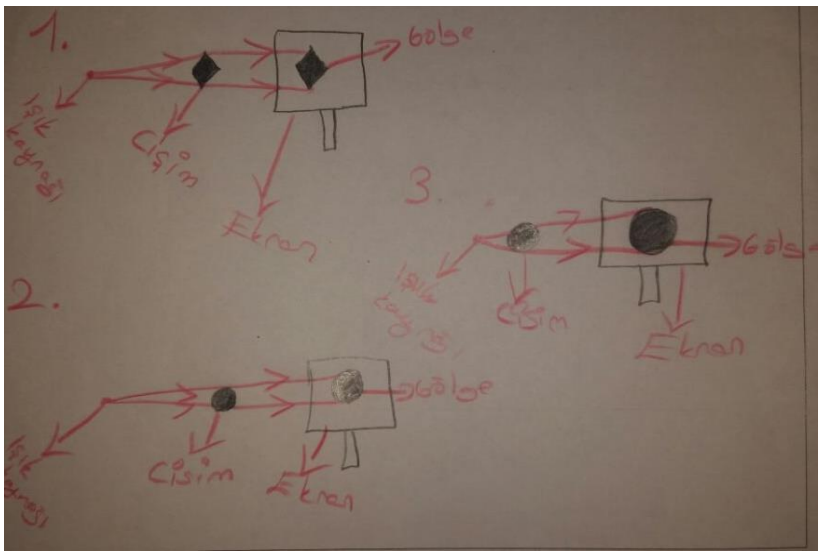
*Shadow Drawing and Information Example for Level 4*



The pupil was told to draw a picture with a shadow. As seen in Figure 4, the child used a correct drawing about the shadow but gave incomplete information. In other words, appearance is correct but there isn't any information how it forms. The light source and the shape of the shadow were correct. However, in his statement, the pupil wrote, "*This is the shadow of the girl*" but he did not give any information about how the shadow was formed. An example of a shadow drawing evaluated at Level 5 is given in Figure 5.

**Figure 5**

*Shadow Drawing and Information Example for Level 5*




As seen in Figure 5, the pupil gave entirely correct and complete information about the shadow. He also made an accurate and sufficient drawing. The light source is in the right place in drawing The shape of the shadow changes according to the object's shape is depicted accurately. The explanation is like that, *"In the first object I made, the shape of the shadow on the object is displayed on the screen. The Square is square; the round is round. In the 2nd and 3rd drawing I made, the object gets bigger when it gets closer to the light source, and it gets smaller when it gets farther away."* In this way, the pupil's existing knowledge of shadow was revealed by both drawing and written expression.

Table 4 shows that the distribution of all drawings, the criteria of which are determined and divided into levels.

**Table 4**

*Distribution of Pupil Drawings by Level*

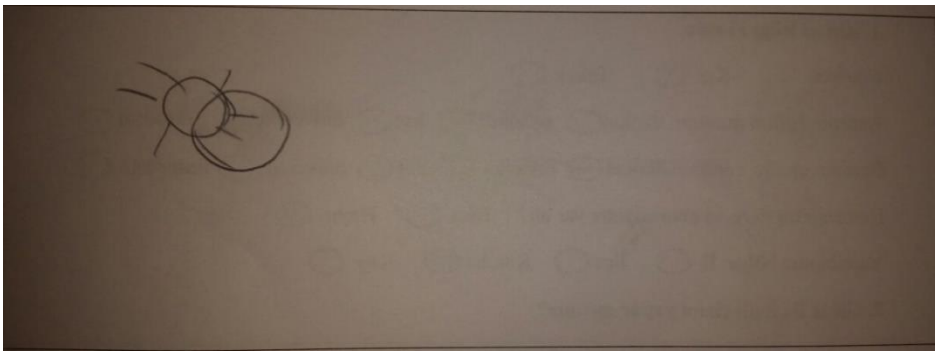
| Levels | Explanations | Frequency (f) | Percentage (%) |
|---|---|---|---|
| Level 1 | There is no light source in the picture.<br>There is no shadow in the picture.<br>There is no drawing in the picture.<br>There is no information under the picture. | 119 | 27 |
| Level 2 | There is a light source in the picture.<br>There is shadow in the picture.<br>The drawing is incorrect in the picture.<br>There is some information under picture. | 102 | 23 |
| Level 3 | There is a light source in the picture.<br>There is shadow in the picture.<br>The drawing is partially correct in the picture.<br>Information is partially correct under the picture. | 80 | 18. |
| Level 4 | There is a light source in the picture.<br>There is shadow in the picture.<br>The drawing is correct in the picture.<br>There is missing information under the picture. | 58 | 13 |
| Level 5 | There is a light source in the picture.<br>There is shadow in the picture.<br>Drawing is correct in the picture.<br>Shadow is correct in the picture.<br>There is information in the picture.<br>The drawing is correct in the light of science curriculum objectives. | 84 | 19 |

Twenty-seven percent of the pictures drawn were categorised at Level 1. The most common categorisations were Level 1 and Level 2. The least one is Level 3.

Another subject that the pupils drew was about the "Solar Eclipse". 5th-grade pupils were asked to draw and explain the drawing about the solar eclipse. The drawings made by the pupils are classified from level 1 to level 5, and the most prominent drawings of the levels are given in Figure 6, Figure 7, Figure 8, Figure 9 and Figure 10. There is a drawing below evaluated at Level 1.

**Figure 6**

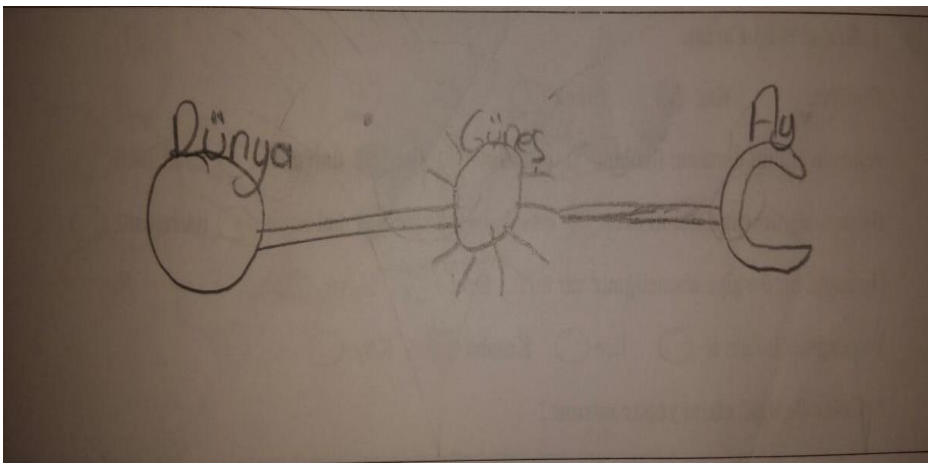
*Solar Eclipse Drawing and Information Example for Level 1*



As seen in Figure 6, the pupil made an incorrect drawing about the solar eclipse and did not explain the solar eclipse. The pupil does not have any information about the solar eclipse based on the drawing. Another drawing evaluated at Level 2 is below.

**Figure 7**

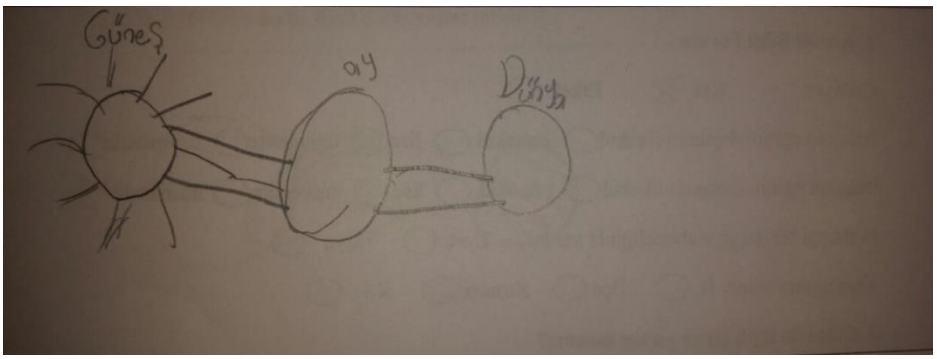
*Solar Eclipse Drawing And Information Example for Level 2*




As shown in Figure 7, the pupil has incorrect information about the solar eclipse. The pupil incorrectly drew the solar eclipse, the Earth, the Sun and the Moon. The explanation made by the pupil is that from the Moon to the Sun, from the Sun to the Moon. As can be seen, the pupil has wrong information about the solar eclipse. A sample drawing from the drawings evaluated at Level 3 is given below.

**Figure 8**

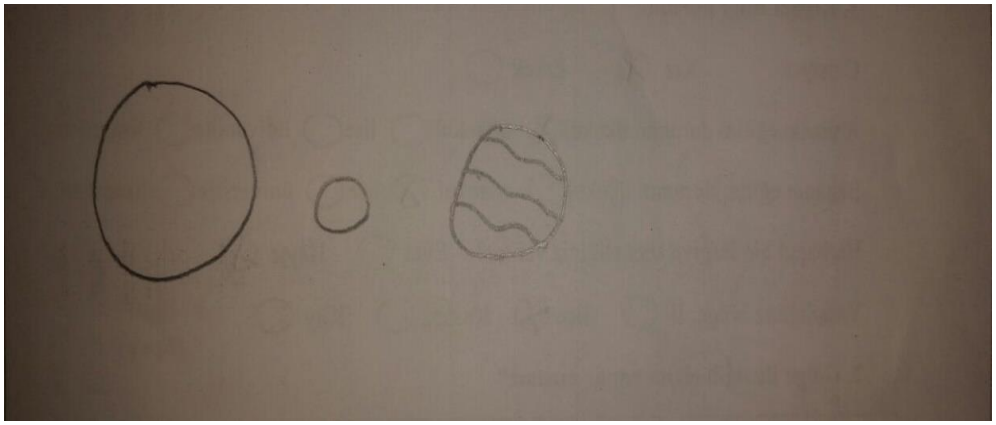
*Solar Eclipse Drawing and Information Example for Level 3*




As seen in Figure 8, the pupil drew a solar eclipse and her drawing is partially correct. The pupil has drawn the solar eclipse correctly. In the information she gave under the drawing, she stated that *"I drew the Sun first, secondly drew the Moon, and lastly drew the world"*. Another drawing evaluated at Level 4 is below.

**Figure 9**

*Solar Eclipse Drawing and Information Example for Level 4*



As seen in Figure 9, the student drew correctly but they had incomplete information about the solar eclipse. In other words, the order of the Sun, Earth and Moon was drawn correctly. However, since the pupil did not write the names of the Sun, the Earth and the Moon, she used incomplete information. In the statement she made, the pupil included the expression "*The sun is at the beginning, the moon is in the middle, and the world is at the end*". An example of a drawing evaluated at Level 5 is given below.

**Figure 10**

*Solar Eclipse Drawing and Information Example for Level 5*

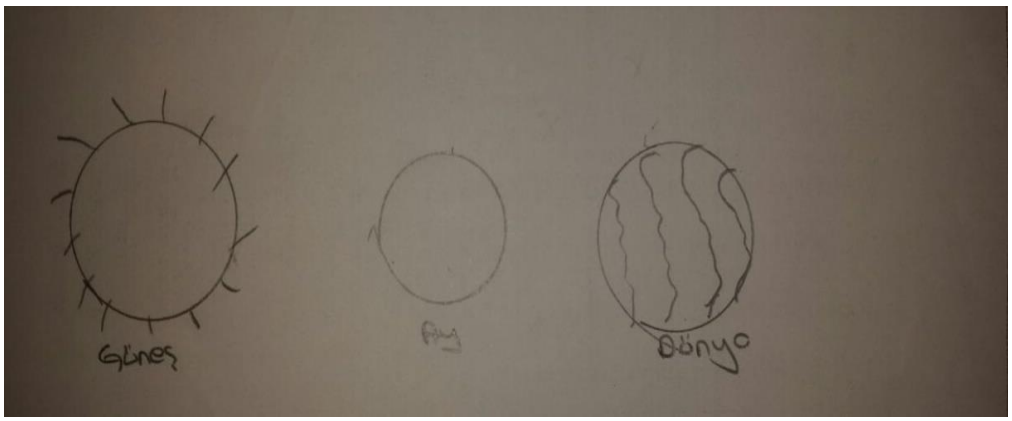



Figure 10 presents that the pupil provided accurate and complete information. Additionally, she had a correct and complete drawing about the solar eclipse. In the drawing, the order and sizes of the Sun, the Earth and the Moon were drawn correctly. The explanation given is "*Solar Eclipse: The Moon is in the middle of the earth with the sun."* Her knowledge of the solar eclipse was revealed both by drawing and written expression. Table 5 presents that there are descriptive evaluation results of the drawings made by the students about the solar eclipse according to the levels.

**Table 5**

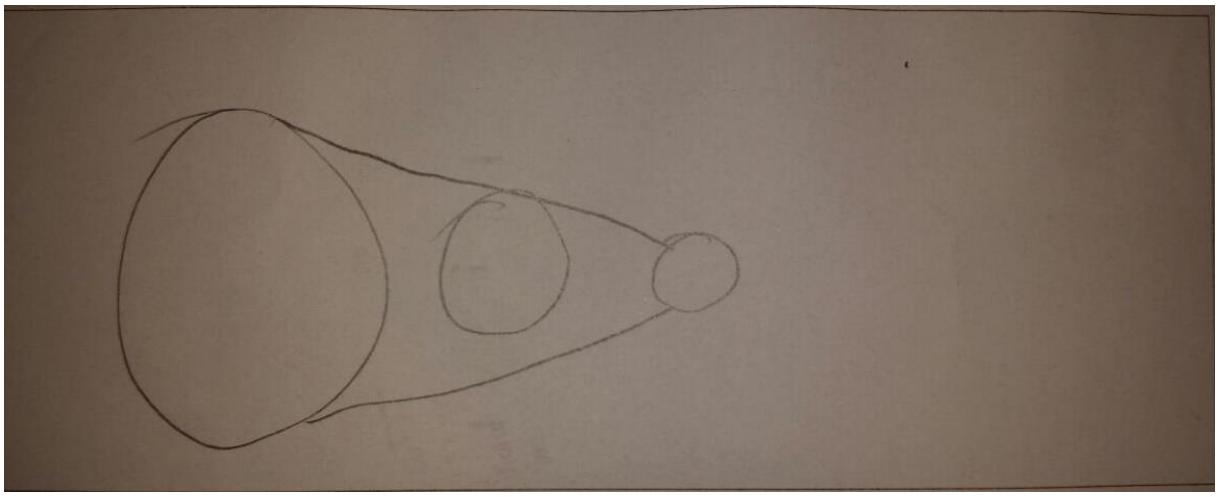
*Results of Information and Drawings about Solar Eclipse According to Levels*

| Levels | Explanation | Frequency (f) | Percentage(%) |
|---|---|---|---|
| Level 1 | There is no drawing in the picture.<br>There is no information under the picture. | 14 | 3.16 |
| Level 2 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is incorrect in the picture.<br>Information is incorrect under the picture. | 90 | 20.31 |
| Level 3 | The drawing is partially correct in the picture.<br>Information is partially correct under the picture.<br>The Sun, Earth, Moon are wrong in size. | 82 | 18.51 |
| Level 4 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is correct in the picture.<br>Information is correct under the picture.<br>Drawings have no names. | 82 | 18.51 |
| Level 5 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is correct in the picture.<br>Information is correct under the picture.<br>Drawings have names.<br>The pupils draw the eclipse on the Earth. | 175 | 39.50 |

Secondary school 5th-grade students were asked to draw a lunar eclipse and explain their drawing. The drawings made by the students are classified from Level 1 to Level 5, and the most prominent drawings of the levels are given in Figure 11, Figure 12, Figure 13, Figure 14 and Figure 15.

**Figure 11**

*Lunar Eclipse Drawing and Information Example of Level 1*



As seen in Figure 11, the pupil made an incorrect drawing about the lunar eclipse and did not make any explanation about it. The drawing shows that the pupil has incomplete information. For this reason, the drawing was evaluated at Level 1. Figure 12 shows an example of a drawing assessed at Level 2.

**Figure 12**

*Lunar Eclipse Drawing and Information Example of Level 2*


Figure 12 shows that the pupil has incorrect information and the drawing is incorrect. The explanation given is "*An eclipse with the Sun, Earth and Moon, its called a Lunar eclipse*". It is seen that the pupil has incorrect information about the lunar eclipse based on the information she has given to the picture she has drawn. Figure 13 shows an example of a drawing evaluated at Level 3.

**Figure 13**

*Lunar Eclipse Drawing And Information Example of Level 3*

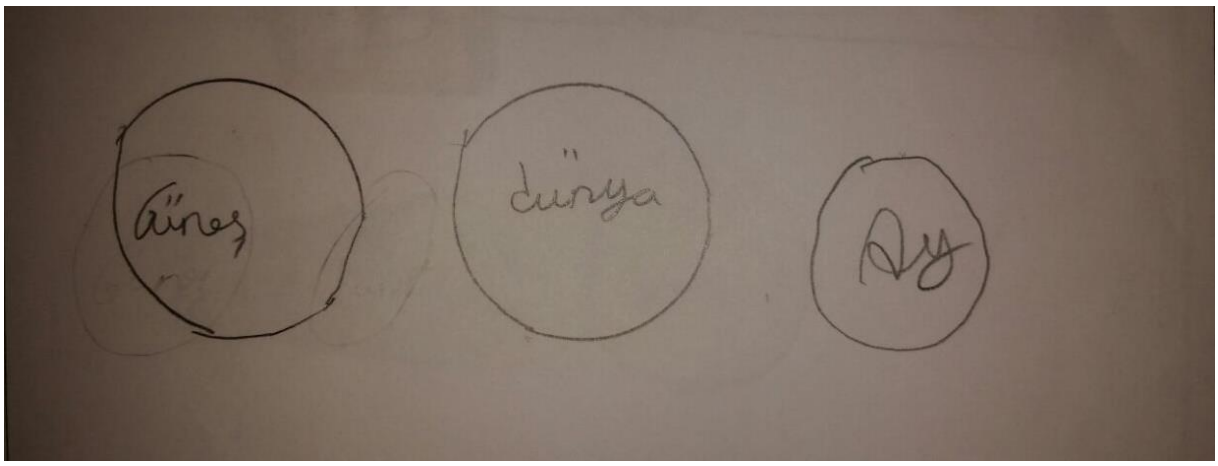
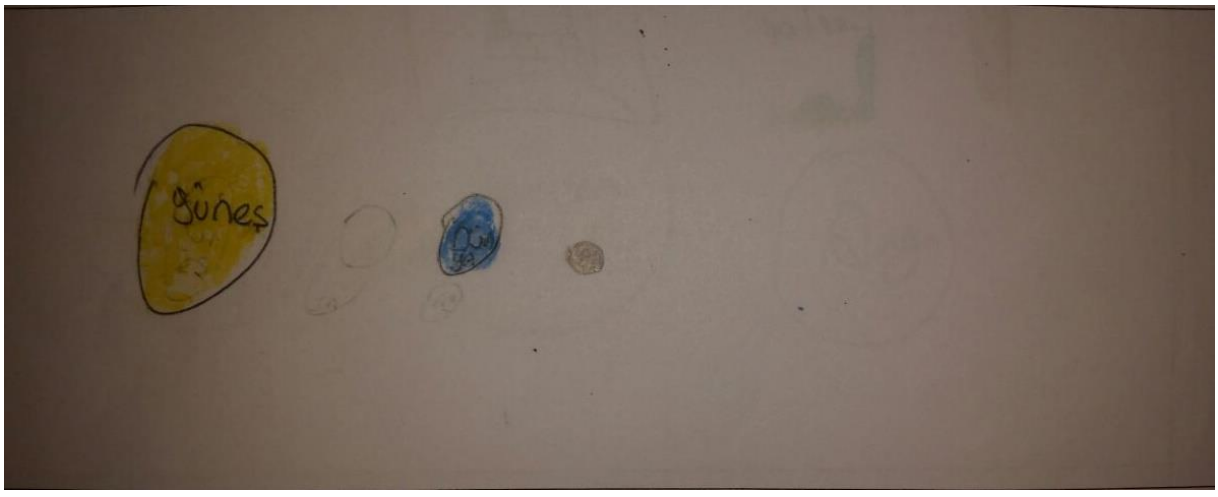



Figure 13 presents that the pupil drew a lunar eclipse and her drawing is partially correct. The pupil drew the lunar eclipse correctly. However, the pupil incorrectly drew the Sun, the Earth and the Moon sizes. She drew the Sun and the Earth in the same size. She wrote that if the Sun, the Earth and the Moon are in our minds, a lunar eclipse comes to mind. So it is partially true. Figure 14 is an example of a drawing evaluated at Level 4.

**Figure 14**

*Lunar Eclipse Drawing and Information Example of Level 4*




According to Figure 14, the pupil drew correctly however he had incomplete information. In his drawing, the order of the Sun, Earth and Moon was drawn correctly. However, he could not fully explain the lunar eclipse. He just said "*the sun comes first, the earth comes the second and the moon comes the third."* Figure 15 shows a drawing example of a Level 5 lunar eclipse.

**Figure 15**

*Lunar Eclipse Drawing and Information Example of Level 5*

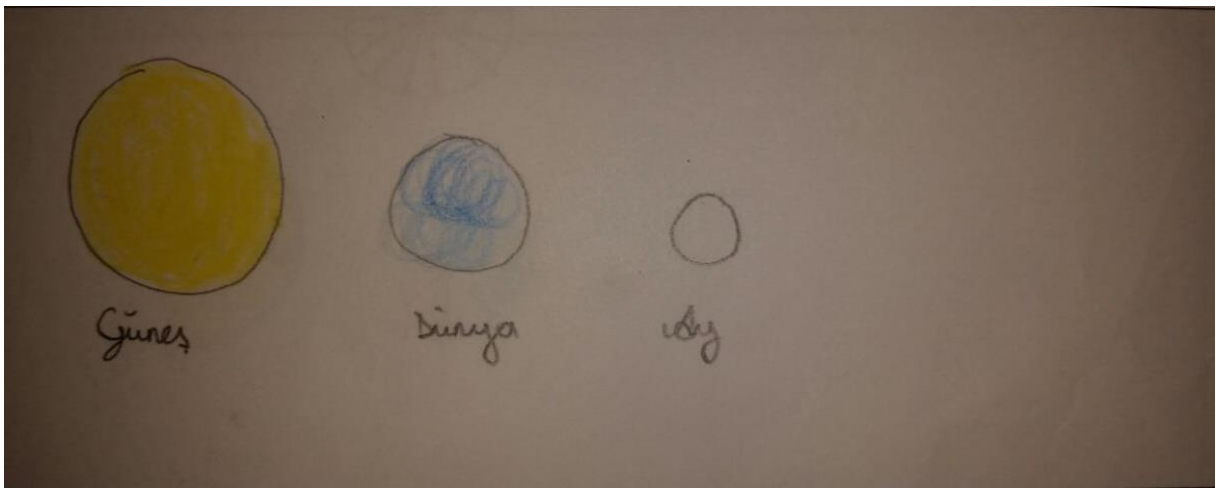



Figure 15 shows that the pupil draws accurately and has complete information about the lunar eclipse. In the drawing made by the pupil, the order and sizes of the Sun, Earth and Moon are given correctly. She also painted the Sun, Earth, and Moon in the right colours. She says "*A Lunar Eclipse occurs when the Earth moves in front of the sun.*". In this way, the pupil's knowledge of the lunar eclipse was revealed Table 6 shows the distribution of information and drawings about the lunar eclipse by level groups.

**Table 6**

*Results of the Information and Drawings of the Lunar Eclipse*

| Levels | Explanations | Frequency (f) | Percentage (%) |
|---|---|---|---|
| Level 1 | There is no drawing in the picture.<br>There is no information under the picture. | 21 | 4.74 |
| Level 2 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is incorrect in the picture.<br>Information is incorrect under the picture. | 121 | 27.31 |
| Level 3 | The drawing is partially correct in the picture.<br>Information is partially correct under the picture.<br>The Sun, Earth, Moon are wrong in size. | 66 | 14.89 |
| Level 4 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is correct in the picture.<br>Information is correct under the picture.<br>Drawings have no names. | 78 | 17.60 |
| Level 5 | There is drawing in the picture.<br>There is information under the picture.<br>The drawing is correct in the picture.<br>Information is correct under the picture.<br>Drawings have names<br>The pupils draw the eclipse on Earth. | 157 | 35.44 |

Table 6 shows the distribution of shadow drawing of the 5th-grade pupils. 4.74% of the pictures drawn by the pupils are at the Level 1 group. It is at the Level 2 group with 27.31%, Level 3 with 14.89%, Level 4 with 17.60%, and Level 5 with 35.44%.

## Discussion

In this research, the perceptions of 5th grade pupils about shadows, solar eclipses and lunar eclipses were investigated based on drawings they made. The pupils had great difficulties drawing shadows. Although most of them knew what a shadow was, they had difficulties drawing shadows. To learn about solar and lunar eclipses, they need to understand what shadow looks like. However, most of the students had problems drawing even if they knew the word meaning of shadow. Some of the pupils forgot to draw a light source. If we compare it according to solar and lunar eclipses, the rate of those who draw the shadow correctly is less. Some of the pupils showed complete shadow formation while others tried to draw the shadows of living (human, plant, animal, etc.) and inanimate (ball, vase, walking stick, etc.) beings.

When we look at the literature, there is no study directly related to shadow. Shadows are included in the Light and Sound unit of the Turkish science curriculum in different grades. For example, in the studies of Çinici and others (2013), Light and Sound unit was processed in virtual and traditional laboratories, and the virtual laboratory classroom was significantly more successful than the traditional laboratory classroom. In the studies conducted by Çeliker and Topal (2011), Uzunkavak (2009), Yüksek Usta and Tezel Şahin (2016), Atasoy, Kadayıfçı and Akkuş (2007), pupils' knowledge was evaluated through drawing. When the given research results are examined, it is seen that the drawing technique is adequate and the drawing style is effective in revealing the pupils' existing knowledge levels and perceptions.

It was observed that most participating pupils drew the solar eclipse as "sun-earth-moon" with the correct relative sizes. Some of them used the expression "the moon comes between the sun and the earth" in the written explanations of the solar eclipse, and it was seen that they wrote correct and complete drawings and accurate and complete. Some students made the correct order of sun-earth-moon but incorrectly drew the sizes of celestial bodies. It was observed that some of the pupils did not use the scientific information they learned in the Light and Sound unit and they had misconceptions about the sizes of the sun-earth-moon. Similar misconceptions have been revealed in the literature by the studies of Taşcan and Ünal (2013), Harman (2016), Kılıç and Kazanç (2017), and Bülbül and others (2013). In the study of Taşcan and Ünal (2013), it was found that the pupils had the misconception about the solar eclipse that the object visible on the Sun during the eclipse is the Earth. In her study, Harman (2016) speculated that this was because the pupils think that the Earth revolves around the Sun, whereas the Moon does not revolve around the Earth and its position is always fixed. For this reason, it was revealed that the pupils expressed the celestial body that they saw as a shadow on the Sun as the Earth. Bülbül and others (2013) determined the perceptions of secondary school pupils about astronomy concepts and concluded that most of the pupils had misconceptions about astronomy concepts and did not match them the scientific knowledge that 8th-grade pupils had learned up to this grade.

It was observed most participants described the lunar eclipse in terms of "sun-earth-moon". It was observed that the pupils who had misconceptions while listing the largest celestial bodies as sun>earth>moon made the correct order of sun-earth-moon, but they drew their sizes incorrectly. In the written explanation of the lunar eclipse, most used the phrase "the earth comes between the sun and the moon". It was ascertained that a significant number of pupils had mental models containing misconceptions about the positions and sizes of the Moon, Earth and Sun during the lunar eclipse. Some confused the solar with the lunar eclipses and drew them in the wrong places. On the other hand, some were not sure whether it was a solar eclipse or a lunar eclipse even though they knew the order of the sun-earth-moon and drew both drawings in the same way. In the studies in the literature, researches were carried out on the positions of the Moon, Earth and Sun in the lunar eclipse. Bostan (2008), Küçüközer and others (2010), Bülbül and others (2013) investigated the perceptions of students

about the lunar eclipse and the misconceptions that occurred in students in their studies. Bostan (2008) revealed the misconceptions of astronomy concepts and lunar eclipse that vary according to the age groups of the students, do not change according to the age groups, and occur in certain age groups. In a similar study, it was stated that although the drawings made by the students were correct in terms of layout, they were incorrect in terms of size and/or distance. The misconceptions about the sizes of celestial bodies may be due to the students' thinking that the planet they live on, as an observer looking from the Earth, has a larger area than the Sun and Moon they see when they look at the sky. Similarly, it has been revealed in the literature that students confuse the lunar eclipse with the solar eclipse (Küçüközer et al., 2010).

Taşcan and Ünal (2013) investigated whether science teachers' knowledge levels of astronomy differ depending on demographic variables. An astronomy knowledge inquiry test was developed to collect data from teachers. The data obtained from the test applied to 100 science teachers were analysed with the SPSS 17.0 statistical package program. The results showed a significant difference in the knowledge level of Science teachers only according to the type of faculty they graduated from. In their study, Öztürk and Uçar (2012) compared the teaching of the 8th-grade students with the method of revealing alternative concepts about the phases of the Moon and teaching the phases of the Moon based on cooperation commonly explaining the phases of the Moon. Conceptual understanding of the phases of the Moon before and after the application was determined through a semi-structured interview. In the cooperative group, students' conceptual understanding levels increased significantly after the application, but there was no significant increase in the control group.

Kılıç and Kazanç (2017), on the other hand, determine the Technological Pedagogical Content Knowledge (TPACK) of the Science (FB) teacher candidates regarding the lunar and solar eclipse. 37 (31 Girls and 6 Boys) FB teacher candidates who were studying in the last year of Fırat University Education Faculty Elementary Education Department Science Teaching program in the 2013-2014 academic year participated in this study. Individual semi-structured interviews were used to determine FB teacher candidates' TPACKs within the scope of Lunar and Solar Eclipse. As a result of the research, it was seen that FB teacher candidates' TPACKs on the subject of lunar and solar eclipses were quite insufficient. The study of Çinici and others (2013) was conducted to compare the effects of virtual and traditional laboratory practices carried out on the 5th grade light and sound unit on student achievement. In the research, the pretest-posttest control group design of the quasi-experimental research model was used. One of the classes was randomly determined as the experimental group in which virtual laboratory activities containing simulations obtained from the EBA database were carried out. The other was the control group, in which traditional laboratory studies were carried out. "Light and Sound Unit Achievement Test" was used as a data collection tool in the research. As a result, it was observed that there was a significant increase in success both in the experimental group in which virtual laboratory activities were performed and in the control group in which traditional laboratory applications were carried out. On the other hand, when the post-test scores of the groups are compared, it is noteworthy that there is a difference in favour of the experimental group.

Mazlum and Yiğit (2016) examined the concept knowledge of 6th, 7th and 8th-grade secondary school students through peer teaching practices in their study. The research is a multiple case study. The research group of the study consists of five students from the 6th, 7th and 8th grades in the role of instructor. The learning students are five students selected from the 5th grade. Before the peer teaching practices were conducted with the teacher students, a preliminary interview was held to get to know them and find out if they were willing to participate in the study. In the study, it was seen that the instructor students mostly associate the concept of light with vision, that the reflection is only on shiny surfaces, that the laws of thought are valid only for smooth consideration, and that the situations that the students encounter in daily life and textbooks are effective in structuring some concepts. It was determined that the teacher students explained the concepts primarily through questions, activities and video animation via smart-board during peer teaching.

## Conclusion

Based on drawings, it was found that many 5th grade pupils harbour misconceptions about shadows, solar eclipses and lunar eclipses. It has been observed that the pupils' perceptions change according to the place they live and they have difficulty drawing and writing something they have learned. It is seen that the majority of students studying in public schools with high socioeconomic levels draw shadows, solar eclipses and lunar eclipses correctly.

## Recommendations

The findings obtained from the research show that some of the fifth-grade students have misconceptions about the concepts of shadow, Moon and solar eclipse, which are among the subjects of the science course. Applied research involving visuals and videos related to the subject can be carried out to overcome students' misconceptions. After these applications, whether there is any change in students' misconceptions can be discussed. Studies of this type can increase students' curiosity about these concepts of the science course and contribute to their academic success.

## Authors' Contribution Rates

This study was carried out with the joint contributions of three authors. The second and third authors conducted a field search (30%). The first author contributed to the study, especially in shaping the method part of the study and ensuring validity and safety (30%). The findings, discussion and conclusion sections of the study were carried out with the joint contribution of three authors (40%).

## Statement of Interest

There is no conflict of interest between the authors of this study.

## Statement of Support

Any institution or organization does not support this work.

## Ethics Statement

It is stated that scientific, ethical and citation rules were followed in the writing process of this study; We undertake that no falsification has been made on the data collected, that the "Editorial Board of the Journal of Turkish Science Education" has no responsibility for all ethical violations, all responsibility belongs to the responsible authors, and that this study has not been sent to any other academic publication medium for evaluation.

## References

Arıcı, B. (2006). Resim, psikoloji ve çocuğun dünyasında resim. *Sanat Dergisi, 10,* 15-22.

Atasoy, B. (2002). *Fen öğrenimi ve öğretimi.* Gündüz Eğitim ve Yayıncılık, Ankara.

Atasoy, B., Kadayıfçı, H., & Akkuş, H. (2007). Öğrencilerin çizimlerinden ve açıklamalarından yaratıcı düşüncelerinin ortaya konulması (çizimler ve açıklamalar yoluyla yaratıcı düşünceler). *Türk Eğitim Bilimleri Dergisi, 5*(4), 679-700.

Aykaç, N. (2012). İlköğretim öğrencilerinin resimlerinde öğretmen ve öğrenme süreci algısı. *Eğitim ve Bilim, 37*(164), 228-315.

Aydın, F. (2011, April 27-29). *İlköğretim 6, 7 ve 8. sınıf öğrencilerinin teknolojiye yönelik düşüncelerinin çizimle belirlenmesi.* 2nd International Conference on New Trends in Education and Their Implications, Antalya.

Bülbül, E., İyibil, Ü. G., & Şahin, Ç. (2013). Ortaokul 8.sınıf öğrencilerinin astronomi kavramıyla ilgili algılamalarının belirlenmesi. *Journal of Research in Education and Teaching, 2*(3), 182-191.

Balım, A. G., & Ormancı, Ü. (2012). İlköğretim öğrencilerinin "maddenin tanecikli yapısı" ünitesine yönelik anlama düzeylerinin çizim yoluyla belirlenmesi ve farklı değişkenlere göre analizi. *Eğitim ve Öğretim Araştırmaları Dergisi, 1*(4), 255-265.

Batı, D. (2012). *Çocuk resimleri ve onların* i*ç dünyalarının resimlerine. [*Unpublished Master Thesis]. Dokuz Eylül University, Institute of Educational Sciences, İzmir.

Bostan, A. (2008). *Farklı yaş grubu öğrencilerinin astronominin bazı temel kavramlarına ilişkin düşünceleri.* [Master Thesis]. Balikesir University, Graduate School of Natural and Applied Sciences, Balıkesir.

Chmiliar, l. (2010). Multiple-case designs. In A. J. Mills, G. Eurepas & E. Wiebe (Eds.), *Encyclopedia of case study research* (pp 582-583). SAGE Publications.

Çelikler, D., & Topal, N. (2011). İlköğretim fen bilgisi öğretmen adaylarının karbondioksit ve su döngüsü konusundaki bilgilerinin çizim ile saptanması. *Journal of Educational and Instructional Studies in the World*, *1*(1), 7-79.

Çelikler, D., & Kara, F. (2012). İlköğretim fen bilgisi öğretmen adaylarının periyodik çizelge konusundaki bilgilerinin çizim yoluyla saptanması. *Eğitim ve Öğretim Araştırmaları Dergisi*, *1*(3), 70-76.

Çepni, S., Küçük, M., & Ayvacı, H. Ş. (2003). İlköğretim birinci kademedeki fen bilgisi programının uygulanması üzerine bir çalışma. *Gazi University, Gazi Eğitim Fakültesi Dergisi, 23* (3), 131-145.

Çinici, A., Özden, M., Akgün, A., Ekici, M., & Yalçın, H. (2013). Sanal ve geleneksel laboratuvar uygulamalarının 5. sınıf öğrencilerinin ışık ve ses ünitesiyle ilgili başarıları üzerine etkisinin karşılaştırılması. *Bayburt Eğitim Fakültesi Dergisi, 8*(2), 90-106.

Demirel, R., & Aslan, O. (2014). The effect of science and technology teaching promoted with concept cartoons on students' academic achievement and conceptual understanding. *Journal of Theory and Practice in Education*, *10*(2), 368-392.

Ersoy, A. F., & Türkkan, B. (2010). İlköğretim öğrencilerinin çizdikleri karikatürlere yansıttıkları sosyal ve çevresel sorunların incelenmesi. *Eğitim ve Bilim, 35*(156), 96-109.

Güven, G. (2009). *Okul öncesi çocuklarının* i*nsan ve aile resmi çizimlerinin* i*ncelenmesi. [*Unpublished PhD Thesis]. Marmara University Institute of Educational Sciences, İstanbul.

Harman, G. (2016). Ortaokul öğrencilerinin güneş ve ay tutulmaları ile ilgili zihinsel modelleri. *Uşak University Journal of Social Sciences*, *9*(27), 297-314.

Hançer, A. H. (2007). Fen eğitiminde yapılandırmacı yaklaşıma dayalı bilgisayar destekli öğrenmenin kavram yanılgıları üzerine etkisi. *Celal Bayar University Journal of Social Sciences, 31*(1), 69-81.

Herdem, K., Aygün, H. A., & Çinici, A. (2014). Sekizinci sınıf öğrencilerinin teknoloji algılarının çizdikleri karikatürler yoluyla incelenmesi. *Amasya Üniversitesi Eğitim Fakültesi Dergisi, 3*(2), 232-258.

Kaya, O. N., Doğan, A., & Öcal, E. (2008). Türk ilköğretim öğrencilerinin bilim insanı imajı. *Eğitim Araştırmaları Avrasya Dergisi, 32*, 83-100.

Kaynak, K. B., & Temel, Z. F. (2015). 4-6 yaşları arasındaki çocukların çizimlerindeki aile algılarının belirlenmesi. *Turkish Studies-International Periodical for the Languages, Literature and History of Turkish or Turkic*, *10*(7), 575-598.

Kara, İ., Erduran A. D., & Çekbaş Y. (2009). Fen bilgisi öğretmen adaylarının ışık kavramı ile ilgili bilgi düzeylerinin araştırılması. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 8*(16), 46-57.

Küçüközer, H., Bostan, A., & Işıldak, R. S. (2010). İlköğretim matematik öğretmeni adaylarının bazı astronomi kavramlarına ilişkin fikirlerine öğretimin etkileri. *OMÜ Eğitim Fakültesi Dergisi*, *29*(1), 105-124.

Kılıç, A., & Kazanç, S. (2017). Fen bilimleri öğretmen adaylarının ay ve güneş tutulması konusuna ilişkin teknolojik pedagojik alan bilgileri. *Turkish Journal of Educational Studies*, *3*(3), 114-138.

Kırbıyık, H., Kızıloğlu, Ü., Kızıloğlu, N., Civelek, F. R., & Beklen, E. (2007). *Evren nasıl oluştu?.* ODTU Yayınları.

Mazlum, E., & Yiğit, N. (2016). Işık konusundaki kavram bilgisi göstergelerinin ve öğretim kanallarının akran öğretimi uygulamalarıyla incelenmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 32*(2), 295-311.

Merriam, S.B. (2013). *Qualitative research a guide to design and implementation.* John Wiley & Sons Inc., New York.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: a sourcebook*. Beverly Hills: Sage Publications.

Milli Eğitim Bakanlığı (MEB). (2010). *Ortaöğretim astronomi ve uzay bilimleri dersi öğretim programı.* Talim ve Terbiye Kurulu Başkanlığı, Ankara.

Milli Eğitim Bakanlığı (MEB). (2013). İlköğretim fen ve teknoloji programı. Talim Terbiye Kurulu Başkanlığı, Ankara.

Okaylı, M. (2015). *Okul öncesi dönem (5 – 6 yaş) ve ilkokul dönemi (7 – 9 yaş) çocuklarında insan figürü çizimindeki gelişiminin incelenmesi. [*Master Thesis]. Okan University Institute of Social Sciences, İstanbul.

Öztürk, D., & Uçar, S. (2012). İlköğretim öğrencilerinin ay'ın evreleri konusunda kavram değişimlerinin işbirliğine dayalı ortamda incelenmesi. *Türk Fen Eğitimi Dergisi, 9(2),* 98-112.

Sadık, F., Çakan, H., & Artut, K. (2014). Çocuk resimlerine yansıyan çevre sorunlarının sosyo-ekonomik farklılıklara göre analizi. *İlköğretim Online, 10*(3), 1066-1080.

Taşdemir, A., & Demirbaş, M. (2010). İlköğretim öğrencilerinin fen ve teknoloji dersinde gördükleri konulardaki kavramları günlük yaşamla ilişkilendirebilme düzeyleri. *Uluslararası İnsan Bilimleri Dergisi, 7*(1), 124-148.

Taşcan, M., & Ünal, İ. (2013, Haziran 29-30). *Temel astronomi bilgileri açısından fen bilgisi öğretmenlerinin ve fen bilgisi öğretmen adaylarının karşılaştırılması.* International Symposium on Changes and New Trends in Education, Konya.

Uzunkavak, M. (2009). Öğrencilerin iş kavramında pozitiflik-negatiflik ayrımı becerilerinin yazı ve çizim metoduyla ortaya çıkarılması. *SDU International Journal Of Technological Science*, *1*(2).

Yavuzer, H. (2009). *Resimleriyle Çocuk. (3. Baskı).* Ankara: Remzi Kitabevi.

Yörek, N. (2007). Öğrenci çizimleri yoluyla 9 ve 11. sınıf öğrencilerinin hücre konusunda kavramsal anlama düzeylerinin belirlenmesi. *Buca Eğitim Fakültesi Dergisi, 22,* 107-114.

Yüksek Usta, S. Y., & Tezel Şahin, F. T. (2016). Çocuk resimlerinde spor. *International Journal Of Science Culture And Sport (Intjscs)*, *4*(3), 214-227.

Yılmaz, E., Türkoğuz, S., & Şahin, M. (2015). Güneş sistemi ve uzay konularına yönelik kavram yanılgılarının günlük yaşama etkisi üzerine öğretmen görüşleri. *Buca Eğitim Fakültesi Dergisi, 37,* 37-44.

Yılmaz, A. & Güven, Ö. (2015). Üstün yetenekli öğrencilerin beden eğitimi dersi ve beden eğitimi öğretmeni kavramlarına yönelik algılarının çizme yazma tekniği ile incelenmesi. *Journal of Qualitative Research in Education*, *3*(3), 55-77.

Yıldırım, A., & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri.* Seçkin Yayıncılık.