

REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

HOW 5TH GRADE STUDENTS SEE THE UNIVERSE

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A thesis submitted by Nesibe Firdevs ÇETİNKAYA in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** is approved by the committee on 12.06.2020 in Department of Mathematics and Science Education, Science Education Program.

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LIST OF ABBREVIATIONS

APKS	Authentic Problem for Knowledge Society
STEM	Science, Technology, Engineering, Mathematics
YTU	Yıldız Technical University

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HOW 5TH GRADE STUDENTS SEE THE UNIVERSE

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Department of Mathematics and Science Education

Master of Science Thesis

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The main points of this article are that in size of the Sun, Earth and Moon and their position relatively and most importantly the shape of the Earth concepts in the students' mind. Students have some thoughts before they are instructed and some of the them cannot change their way of thinking even, they have been persuaded to the concepts. In this research there are three problem that needs to be answered which are how the 5th grade students define the size and shape of the Sun, the Earth and the Moon and their position relatively to each other, what misconception the students have in terms of the size and shape of the Sun, the Earth and the Moon and their position relatively to each other and how the 5th grade students image the size and shape of the Sun, the Earth and the Moon and their position relatively to each other as three-dimensionally. In method there two section one of them is forced question questionnaire and interview among the students who participate questionnaire. forced-open question had been asked which was adapted by [8] for the shape of the Earth. They which are in 5th grade was consisting of around 78 students.

When we look at the results, the terms are mixed. There is still misconception about the shape of the earth. Moreover, the most misconception are encountered in the position of

sun, earth and moon. The students have trouble to understand the fact when is not compatible with their daily experiences.

Key words: Misconception, sun, earth and moon, forced question questionnaire

5. SINIF ÖĞRENCİLERİ EVRENİ NASIL ANLAMLANDIRIRLAR?

Nesibe Firdevs ÇETİNKAYA

Matematik ve Fen Bilimleri Eğitimi Anabilim Dalı

Yüksek Lisans Tezi

Danışman: Prof. Dr. Bayram COŞTU

Bu makalenin ana noktaları, Güneş'in Dünya'nın ve Ay'ın şeklinin anlaşılması ve Dünya'nın Güneş'in ve Ay'ın birbirlerine olan konumlarını ve büyüklüklerinin karşılaştırılmasıdır. Çoğunlukla öğrencilerin kafalarında canlanan Dünyanın şekli daha çok araştırmanın ana hattını oluşturmaktadır. Öğrencilere öğretilmeden önce bazı düşünceleri vardır ve bazıları bile düşünme şeklini değiştiremez, yeni kavramlara ikna edilmeleri bu yüzden zordur. Bu çalışmada, 5. sınıf öğrencilerinin Güneş, Dünya ve Ay'ın boyutunu ve şeklini nasıl tanımladıklarını ve birbirlerine göre konumlarını nasıl belirlediklerini, öğrenciler açısından ne anlama geldiklerini belirleyen üç problem vardır. Güneş'in, Dünya'nın ve Ay'ın büyüklüğü ve şekli ve birbirlerine göre pozisyonları ve 5. sınıf öğrencilerinin Güneşin, Dünya'nın ve Ayın boyut ve şeklini ve birbirlerine göre konumlarını üç boyutlu olarak nasıl gördükleri. Buradaki yöntemde, iki bölümden biri yönlendirmeli soru anket formu ve ankete katılan öğrenciler arasından 4 öğrenci ile röportaj yapılmıştır. [8] tarafından Dünya'nın şekli için uyarlanan zorunlu açık uçlu sorular soruldu. 5. sınıftaki öğrenciler yaklaşık 78 öğrenciden oluşur.

Sonuçlara baktığımızda terimlerin karışık olduğu gözlemlenmiştir. Dünyanın şekli hakkında hala yanlış bir anlayış vardır. Dahası kavram yanılgılarının en fazla olduğu yer

Güneş, Dünya ve Ay pozisyonunda rastlanmıştır. Öğrenciler, en çok kavramları günlük deneyimleri ile uyumlu olmadıklarını zaman anlamakta zorlandıkları gözlemlenmiştir.

Anahtar sözcük: Kavram yanılgısı, güneş, dünya ve ay, yönlendirici sorulardan oluşmuş anket

INTRODUCTION

Ancient civilizations had different beliefs about the shape of the Earth. In China during the Shang Dynasty, the shape of the Earth was imagined as a cross in which people lived in the center of the cross. On the two arms of this cross, it was believed that the world of souls existed. Later, the ancient Chinese civilizations believed that the Earth was a flat square and that the sky was carried by the mountains in four corners [1].

This belief in the Shang dynasty that reigned in 1760-1046 is a sign of the try of the people's understanding of the world in which they live. They want to make meaning explanation with their sees and observation which are limited because of past technological improvement.

In the Babel Civilization, the Earth was depicted as a hollow sphere, and the space of the Earth was believed to be a place to live after death. In this research still humankind has this kind of thoughts of shape of earth in now days.

The earliest sources of humanity believe that the shape of the Earth is dated back to 500 years old. Aristoteles supported the fact that the Earth was sphere-shaped and depended on the inclination of the shadow that the Earth lefts on the Moon. Aristoteles, who also attempted to calculate the Earth's diameter, explained its calculation as 73,225 kilometers.

Shortly after Eratosthenes found the environment around the world, the Ancient Greeks managed to find the distance of the moon from the world. For this reason, the Greeks used it in the morning, when the sun and moon were seen. On a morning like this, the moon was half-moon (first four) in the sky. In other words, the world was composed of a right triangle between the sun and the moon. The distance between the earth and the moon was calculated. When the angle between the sun and the moon was calculated, the distance of the moon from the world could be calculated.

All of this early finding encourages us to ask more questions about the universe that we are a part of it. Nearly every human thought from history to now try to understand and

make comment about the universe no matter the conclusion will be. Earth has a big part of this curiosity of the universe, since human are more likely think from nearest thing that around. The second place belongs to the moon which is the orbit shy in the night.

When the people raise their head, they see the sky. The sky which is bright in the daytime and dark at night and it has sun and moon. The person who is capable of imagining began to wonder what happening in the sky. From the beginning of life, people sense their life in earth is somehow related with what they saw in the sky. Sun is source of life and Moon cause of tides etc.

They like to have a guess on what is going on the top of them. Sometimes they guess wrong such that the earth is flat and the sun rotating around the earth, however they have been kept searching answer from those predictions. Those misinterpretations and failure bring us to our today's knowledge accumulation. However, it is surprisingly, the previous mankind misinterpretations are observable in those people in early ages. Even elderly people and adults have these thoughts. How interestingly that we see the clues proving that the world is round, but we still think we will fall at the edge of the world [19].

Moreover, we say that the sun is incredibly big when we compare to the earth. Still the students can draw the sun as equal as the earth [19]. This is natural when we think that the students live in earth which should be big. He/she thinks that the earth is big, since getting some placed to another places is required lots of time.

1.1 Literature Review

1.1.1 Children Understanding of the Space Subjects

The space subject is hard to have an imagination about and thus it leads to some different explanation about the space. The size of the space is mostly beyond the capacity of someone's imagination. Especially for those students who has limited small living places. Although, the visual imagine from internet, tv or documentary provide tremendous clue of the space, some of the people cannot build bridges between what they assume and what they have learnt. Astronomy is one of the subjects where children meet great difficulties because of the inconsistencies between what is experienced and what is taught [3,4].

Cognitive theory concentrates on the conceptualization of students' learning processes. "It focuses on the exploration of the way information is received, organized, retained and

used by the brain.” (p. 11) [5]. The student should have an explanation of the size of the Sun by comparing with the size of the Earth. So, they need to first organize the size of the Earth then they need to determine the Sun. It has logic which the students are more familiar with the Earth where they live. However, they see the sun by looking at the sky, however they do not see the Earth by naked eyes.

Also, the movies, book and any visual source is a basis for the knowledge and information. It becomes more important how the students see the Sun and Earth as concepts which can be considered as ideas, objects or events that help us understand the world around us [6].

There are number of science educators, such as Nussbaum and Novak [7], have investigated children’s knowledge about the shape of the earth and have a result of the children hold various term about the shape of the earth. Nowadays, the students know that the shape of the earth is round, however when you deeply investigated this information you can encounter with the answer such that they have a dual misconception. They can also say that the earth has an edge from which people can potentially fall off, and people cannot live at the bottom of the world [8].

In mental model of the shape of the Earth, [19] collect data with evaluating the previous studies. One of them is that children think that the Earth is flat. This assumption date backs very old. In the older ages the people thought that was the true idea, since when you live in the Earth it is hard to observe roundness around you.

It seems that the ground is flat when we look at it where we live. The other one is shape similar with CDs, such that it is round, but it is still flat. The children interpret this information by looking at the picture or visual sources from taken by space and they say the Earth is round, however when they look at the ground where they live, they see flatness.

1.1.2 The Curriculum of the Science in Turkey

The Ministry of National Education aims to educate all individuals as closely related individuals within the scope of the Science curriculum. The Science Education Program has major objectives. These aims are:

- 1) To ensure that science is closely equipped with enough equipment,

- 2) To make use of scientific process skills to understand the relationship between nature and environment,
- 3) To suggest the relation of technology and societies with science,
- 4) To make people aware of the interaction between the society and to make them think about how the resources in the environmental factor will be continued to the future,
- 5) To have knowledge of having professional advancement related to science,
- 6) To ensure the acquisition of responsibility in the face of the problems during the day and to make use of the skills acquired in science to solve these problems,
- 7) To provide an understanding of the stages through which information is being passed and how it is used in related researches,
- 8) To ensure that science is developed with the contribution of all scientists,
- 9) To know the effects of science on the problems and technological developments in the society,
- 10) To arouse curiosity for the events occurring in daily life
- 11) To realize that security is important when conducting scientific studies,
- 12) To ensure scientific thinking [9]. And to educate scientific literate students.

In the 3rd grade there is objective which says that the student realizes that Earth's shape is like a globe [10]. So, when the students come to 5th grade, they already know the shape of the Earth is similar with round, but they do not learn earth has geoid shape. With this information I will satisfy with the answer of round, not with geoid.

When we look at the 5th grade curriculum the students become familiar with the shape of the sun. The geometric shape of the Sun is referred [10]. Moreover, in this grade they have an objective to make them visualize the proportion of Sun and Earth. They prepare the model to compare the size of the sun to the size of the Earth [10]. It means that they learn size of the Earth first then they compare with the Sun. Firstly, the students' needs to make sense of themselves. "Learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting that construction rather than communicating knowledge" (p 171) [11].

Until the students become 5th grade, it is important to giving the meaning of the size of the Earth. It is also important to how they define the size of the Earth. They might say that the earth is bigger than where they live. They need to also define the size of their environment.

In the second subject of the 5th curriculum is related with the Moon. Again, the students can observe the moon by looking at the sky. However, by looking at the sky the students observe mostly the size of the Sun and Moon relatively close to each other. To eliminate this misconception the teacher says as a reason that the sun is far away from the moon and because of that reason it seems that the Sun has similar size with the Moon. In the objective there is no comparison between the size of the Moon, Earth and Sun. The size of the moon is specified, and the geometric shape of the moon is referred to [10]. There is no three-dimensional model in that subject too. However, these is another objective that can provide this lack of information which is that the students prepare a model representing the movements of the Sun, the Earth and the Moon relative to each other [10]. In this objective, the students now can use the information of the size of the Sun, the Earth and the Moon. Beyond that the students able to see their relatively position relative to each other. The question here would be how the students visualize this model in their imagination?

1.1.3 Misconception in Space Subjects

There are different terms have been used to refer to this type of knowledge-such as preconceptions [12], misconceptions [13], alternative frameworks [14], mental models [15,16], folk theories [17], and intuitive theories [18]. So, some of the academic studies choose mental model for misconception, but researcher agree with that some of the intuitive knowledge needs to be meet an agree with the scientific knowledge. Vosniadou and Brewer claim that mental models should be discovered very carefully by doing that the conceptual change is more possibly to happen [19].

Misconceptions, on the other hand can be described as ideas that provide an incorrect understanding of such ideas, objects or events that are constructed based on a person's experience [20] including such things as preconceived notions, non-scientific beliefs, naïve theories, mixed conceptions or conceptual misunderstandings [21]. "Piaget suggests that children search for meaning as they interact with the world around them"

(p.281) [22]. Misconceptions are related to misinterpretation of information or disorganizing with the giving information.

The learning does not start from the very bottom of the human experiences. Knowledge is stored in the association or linked between that previous information. In the background of the learner there are structured concepts which the learners use those concepts to link the new ones that they will have been learned. However, the learners are confused sometimes to accommodate or organize the information which can lead the misconceptions.

When this situation arises Posner et al's [23] suggests the four steps to accommodate new information or conceptual change. One of the steps is there must be dissatisfaction with existing conceptions. They should be changeling and confusing situation that the learners want to leave their assumptions. The second one is a new conception must be intelligible which should make easy to accommodate the new input in the place of old one. The third one is a new conception must appear initially plausible. This is the moment the learner accepted there are inconsistency with that they learnt. The last one is a new concept should suggest the possibility of a fruitful research program. Giving more examples until the learner satisfied. These steps are a proof that the conceptual change is not happen quickly. "The misunderstanding that occurs in the mind of learners is a serious thing that should have been interested. People resist making such changes, unless they are dissatisfied with their current concepts and fed an intelligible and plausible alternative that appears fruitful for further inquiry" (p.223) [23].

A teacher we cannot totally be aware of how the students imagine the abstract concepts. If the teachers are aware of the way of students' thinking, they can reach the students insight learning effectively. This subject has been chosen, since the students nearly meet abstract concept first in their academic life. Before becoming 5th grade they know these concepts from surrounding, however in school they have been evaluated from their knowledge firstly.

A series of studies have shown that children have difficulties in understanding that the earth is a huge sphere, surrounded by space [24], [25], [7], [19], [26]). Studies have revealed that students, even graduates from prestigious universities and preservice teachers, usually have a common misconception about the shape of the Earth that the

Earth has flat surface. How to help students understand the scientific conception about the shape and size of the Sun, the Earth and the Moon and their position relatively be an important issue for science educators. Therefore, the purpose of this study was to implement and then investigate the possible instructional effects in helping students to articulate scientific understandings about the shape and size of the Sun, the Earth and the Moon and their position relatively.

1.1.4 Drawing vs Three-Dimensional Modelling

Vosniadao et all's methods of revealing students' ideas has been criticize on a number of other researchers [27], [28], [29], [30]. To be able to reveal the children's thought in space subject, there has been several methods that has been used in researches such as, drawing [4], open-ended question [4, 27, 28], forced questions [29,36], 3D model [45], making clay model [8,74] and etc. Each of these techniques has advantages and disadvantages but there is a common ground that all the researchers who has been studying his area choose at least two of these methods together in their study. It is reasonable that using only one method among them makes your argument might be weak. There should be several kinds of answer that needed to collect by different method to use interpret in branches of subjects.

As it mentioned above, the children already know about too many things about the space subject, so there should be great investigation to reveal all the thought that they might have in their imaginary world. Siegel, Butterworth and Newcombe [31] have stated that students know comparatively more about the space than was previously realized.

There are number of reason that dissimilar methods might differently affect the outcomes from the thoughts of the students have. Firstly, drawing, making clay and 3D model has different kind of skill that the students might have. Such as, the drawing the spherical earth or the distance between sun, earth and moon has a talent of visualizing and drawing. Drawing spherical object into the paper in two-dimension is a hard skill to not everybody can cope with it. Asking students to draw pictures might lead them to depict the earth as flat or dual since they have lack of talent at drawing three-dimensional objects and have struggle in combining perspectives [32], [33], [34]). Another methodological critique of the Vosniadou and Brewer's [19] study is their use of drawings. Siegal et al. [45] advocated that the use of drawings encouraged flat representations of the earth in the

Vosniadou and Brewer study [19]. However; 3D model is not selected in this research, since to satisfy the intended aim of the research the drawing method has been selected. Drawing method would provide a greater number of students that has been answered the questions which engage the more data in classification of the earth model such as flat, hollow, dual and spherical. Moreover, it has been thought that the distance between the space subject; earth, sun and moon can be seen easily in drawing rather than 3D model. Although there is some research that advice to use 3D model rather than drawing such that the use of open questions, drawings or model-making tasks may be problematic. There are reports that students, and even adults, find these tasks to be ambiguous and therefore, often fail to express their knowledge accurately [35], [36], [37]. Also, students might give different answer when researchers use three-dimensionPanagiotaal method instead of drawings.

1.1.5 Open Ended Questions and Interview

The second possible reason for using open questions resulting in more incorrect responses is student's tendency to often misinterpret the questions they are asked during interviews [39], [40], [41]. The age of the students could not be suitable for the open questions. Most of the students have different idea than you asked to those students. Even you clearly define the answer that you seeking they think different else too. However, the forced question might lead them to more accurate answer that you are looking for. It seems that the data interfered in this way, nevertheless it restrains the jumping another subject that you are not interested in. Even the adults can not contribute the subject with the desirable, since the subject is suitable for every discussion.

In addition to that, it has been putted forward that the purpose of open questions is often unclear to young students. As a result, many children are prone to respond incorrectly, even when their implicit understanding of a concept is correct [42], [43], [44], [45]. The forced question might eradicate the ambiguity of the thoughts that the pop into the students' mind when they read the question.

For example, in open ended questions, children are giving the answer is the Earth is round, but when you ask forced-choice question, they reveal the flatness in somehow. [19]. "It was predicted that the forced-choice method of questioning would produce more scientifically correct responses than the open method of questioning because it tests

children's recognition of scientific information and not their ability to use this information generatively" (p. 208) [8]). Vosniadou and Brewer [19], showed that young children had considerable difficulty in understanding the scientific concept of the earth as a rotating sphere whose revolution around the sun causes the day/night cycle. "Although most of the children knew that the earth is round, they also believed that the earth has an end/edge from which people can potentially fall off and thought that people cannot live at the "bottom" of the earth. Detailed examinations of the individual children's responses showed that a great deal of the apparent inconsistency could be explained by assuming that the children had used in a consistent fashion a mental representation, a mental model, of the earth that was different from the spherical earth model." (p.203-204) [8].

There is some defection of the students' ideas about the shape of the earth which are the "flat earth" with people and the sky on top and an edge from which one can fall; the "hollow sphere" with the sky located inside the Northern Hemisphere and the people situated inside at the bottom of the earth; the "dual earth" consisting of a flat earth where people live and a round earth that is up in the sky; and the "spherical earth" that is round with the people and sky around it [19]. Vosniadou and Brewer construct these mental models by changing the style of question. Firstly in 1992 they asked open ended questions such as: What is the shape of the Earth? Then they change the questionnaire to forced choice such as that If you moved in one direction for many days where would you end up? When you change your question into this the children may give answer that people can fall. Mental model such as dual earth, spherical earth, hollow earth and flat earth is more appropriate for revealing by forced choice questionnaire.

According to research of Vosniadou and Brewer [4], the answer of the question which is if you moved in one direction for many days where you would end up is classified to consisted mental models. The students who writes if you moved for many days, you would reach the edge of the Earth/ end of the earth are categorized into disc/ flat earth. Another response that the students might give the answer of not applicable of if you moved for many days, you would reach the inner side of the sphere are categorized into hollow earth. Moreover, the students who writes if you moved for many days, you would reach the edge of the earth or the round earth in the sky has no edge are categorized dual earth. In the fourth category the students who write if you moved for many days, you would reach the side of the earth are categorized flattened earth. In the final category the

students who write if you moved for many days, you would end up back where you started are categorized spherical earth. Although the research's label in detail is a helpful tool for this research.

A different view concerning the nature of children's conceptions of the earth is based on studies that, instead of drawings and open questions, have used three-dimensional (3D) model selection tasks and forced-choice questions [8], interview [46] and a paper-and-pencil test (EARTH) [47]. These researches are mostly interested in shape of the Earth, day-night cycle and gravity.

1.2 The Objective of the Thesis

The purpose of this paper is that to reveal students' view about the children's concept of Sun, Earth and Moon. In this research it was revealed students' views about size of the Sun, Earth and Moon and their position relatively and most importantly the shape of the Earth concepts in the students' mind. After the teacher gives instruction, do they change of their previous assumption about the Earth, Sun and Moon or do they insist the continuity of their thoughts? Some of the thesis or academic research has a similar topic, but they also include how day and night and season occur [8, 31, 44, 73]. Those subjects was not be placed in this research, since in the curriculum of Turkey do not include those subjects in 5th grade. The curriculum is a boundary and is a reference guide.

1.2.1 The Importance of the Thesis

It is an important subject to research, since students have some thoughts before they are instructed and some of them cannot change their way of thinking even when they have been persuaded to the concepts. In this thesis there were investigation of the students' keeping thought of given aforementioned. To be able to learn that they cannot change the previous learning what they are assuming is important to change of our instructional method. However, in this thesis there will be no solution for the overcome misconception of the students which is related to the astronomy, except in this thesis there will be a research of the thoughts the students have in astronomy especially their misconceptions. The main point of the research is a misconception in the shape of earth. Followingly, the size of the sun, earth and moon could have not been understandable for those in 5th grade and similarly, the position of sun, earth and moon how change according to the students.

The question would have been asked that although, there is so much visual material, space is still an abstract concept for the students.

1.2.2 The Problem Statement of the Research

In this paper I searched for answers on the following research questions;

- 1) How the 5th grade students define the size and shape of the Sun, the Earth and the Moon and their position relatively to each other.
- 2) What misconceptions the students have in terms of the size and shape of the Sun, the Earth and the Moon and their position relatively to each other.
- 3) How the 5th grade students image the size and shape of the Sun, the Earth and the Moon and their position relatively to each other as three-dimensionally.

To find answers for these questions, my study is located within a paradigm of constructivism. That is, according to constructivism as a paradigm, individuals form the realities from their experiences and thoughts [2], so since my research questions. also depend on individuals' thoughts and experiences, this paradigm informs my research questions.

1.3 Hypothesis

The problem of thesis has been given rather than hypothesis has been placed, since this academic research is not quantitative one.

METHODOLOGY

2.1 Method

This section contains information about the research model, the study group, the data collection tools, the source and type of data, the application of the research and the analysis of the data. Action research method has been chosen to the chance of breaking down the wonder in a more prominent profundity each time, therefore bringing about greater level of comprehension of the issue. Teacher researchers are committed to practice study, mainly because of its own situation rather than the custom of another. In that sense, they are engaged in participation or self-reflective teaching. In other words, they reflect about what they know and what they should do for improving their own learning situations. [80]

2.2 Research Model

In methodology, forced-open question had been asked which was adapted by Vosniadou, Skopeliti and Ikospentaki (2004) [8] for the shape of the Earth. Then similar question has been added which was about the position of Sun, Earth and Moon by relatively. The students draw picture related to the both the shape of the earth and the position of sun, earth and moon relatively with each other. Convenient participant has been chosen to able to convenient student for the interview part. Two classrooms had been placed which was mostly consist of 40 students in each classroom. However, some of the students were absent so they could not be participant. In total there are 78 students who answer the open-ended questionnaire and there 4 students who have been made interview with.

Before the application of the open-ended questionnaire the adapted questions have been asked to the students to see whether the questions are suitable for our students. No problems were encountered. At the end of the questionnaire the students were asked to draw pictures of earth, sun and moon. Some of the students was been selected to make interview according to their answer to the questionnaire. Interview had been done to clarify the misconceptions in the subjects. Some of these students has been chosen since

they clearly have common misconceptions and the other one seems does not have misconception at all.

2.3 Participants

The study has been placed in one of the Secondary School, which is located in Ümraniye, İstanbul. İstanbul is the largest city of Turkey. It has nearly 15 million people.

In İstanbul, there are more than 3 million students in 6 thousand 127 schools, including 2 million 785 thousand formal and 310 thousand in open education [48]. The population of Ümraniye is 690.193 [49]. There is no data of how many students go to secondary school in Ümraniye, but Ümraniye is the 5th biggest district in İstanbul. So that makes the group of students of Ümraniye a majority represent in Turkey.

İstanbul is a metropolitan city which take immigration from the all places in Turkey. Similarly, Ümraniye has the same background of population. People who lives in Ümraniye has low and middle socio-economic level which is similar with İstanbul and Turkey. All of these features create opportunity for the research in terms of participations.

Moreover, two 5th grade classrooms had been chosen for the research. The age of the participants is between 10 and 12. They are in 5th grade consisting of around 78 students. Knowing the students with their background might give a help of guessing the students' answer more appropriately.

There were eight questions. Three of these questions require drawing. These three questions are;

- 1) What is the shape of the world? Can you describe it?
- 2) Can you show me where the sky is on the picture?
- 3) Can you draw a model considering the magnitudes of the Sun, Earth and Moon and their distance to each other?

These questions also have a great impact of choosing the students for interview. For previous reading I was prepared for the ambiguity.

Another question that makes the students are best choice for the interview is that

If you keep walking on a straight line for days, where do you go? Again, from previous reading this question needs backup to be more understandable for the younger ages such that

A person begins to walk eastward from Turkey find where he/she are? Note: You can easily overcome the mountain or sea. Moreover, there should have been a map to even be clearer. Nevertheless, two-dimensional map makes the students giving more wrong answer.

When the students entered the forced-choice questionnaires their paper was classified with number, so there will be no name on them. However, some of the students' paper set aside for interview. The four students had been selected from the questionnaire. Students are selected according to the criteria of eligibility, outward character and voluntary.

2.4 Data Gathering

Some of the question in the questionnaire has been adapted from [8] to able to define students' misconceptions. Some of the question is taken from forced question and the others are taken from open-ended questions.

First question from this research has been taken from the 14th question of the research' open-ended questionnaire. There are similar questions such as the first question in forced questions which is "How do you know that the earth is round/flat?" (p.210) [8] This is leading for the students and it is not wise to ask this question in a way like that. The other different type of the question is placed in the research is what is the shape of the earth? (p.210) [8] If the earth is round, does it look like a circle or a ball? Although is an open-ended question the second part of the questions is leading the students to two answer only. In this research the question is what is the shape of the earth? (p.210) [8]

The third question which is if you walked for many days in a straight line, would you fall off the edge of the earth? Why/ why not in the study was taken in the same way but was asked in two questions. The third and fourth question of this research has been adapted from (p.210) [8] in same. However, "why" question is not used in the questionnaire due to the lack of the time. Surprisingly the open-ended question in the research is more guided for student. If you walked for many days in a straight line where would you end

up is there an end or an edge to the earth? Would you ever reach the edge of the earth? Would you fall off that edge? Why/ why not? (p.210) [8] the question of would you fall off that edge has clue for the students and is not suitable for this research.

The second question of the research is taken from the second question of the open-ended question which is how you know that the earth is (p.210) [8]. Forced questions which is how you know that the earth is round/flat is leading to two answer again.

The 5th question of the research is taken from the [8] and adapted in different way. The question has been supported visually. The question of “can people live up here? Can they live down there? Show me where the people in Greece live” (p.210) [8] has been turning to

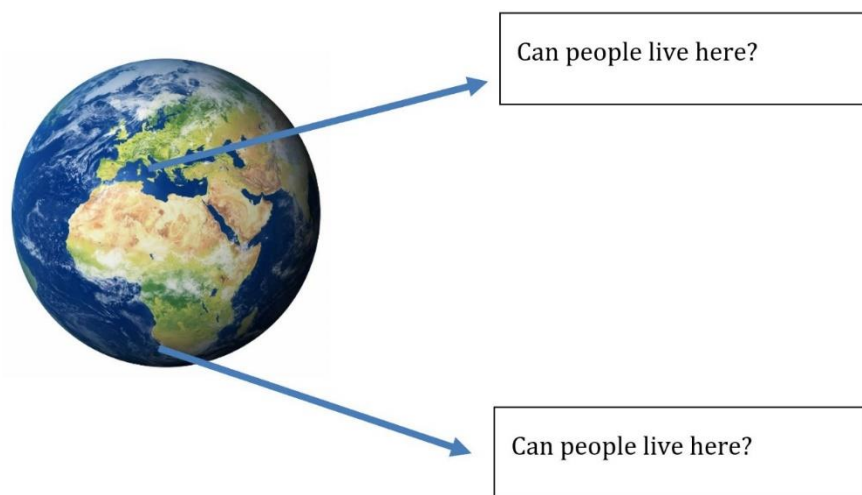


Figure 2.1 Shape of 5th questions

In the interview part the students had been asked same question in the questionnaire. There were no differences between, since the data was limited with those questions. The space is tremendous subject is needed to be examine carefully. Some of the most studies have been neglected due to the curriculum or limited time. Even asking the 8 question only took 40 minutes to be answered. Interpreting and discussion should take much more from that.

2.5 Questionnaire

In this part, data will be examined into two section which are questionnaire one by one and then interview with the students. Firstly, the questionnaire that had been asked to the students consists of 8 different question which require short and long answer. There is not multiple-choice question in the questionnaire to not directed to the answer. So, they can reveal their misconceptions. Then among these students who gives different and interesting answer to the questionnaire will be chosen for the interview.

Data and results will be shown altogether in this section for one question after that it will be pass the next questions. Then there will be summary ones more and the end of the section.

In here, I explain that

- The aim of the question: why we are asking this question, why it is important for our research and how leads us to the students' misconceptions.
- This relationship of the question to the students' misconceptions: the students how specific misconception has responded to this question. Basically, the answer of the student's links to the which of the misconceptions.
- The question itself: this research had been placed in Turkey, so that the questions were in Turkish which will be translated into the English.
- How the questions make correspond in the curriculum of Turkey: as we mentioned in the introduction part, we will explain what the students know about the subject
- The responses of the students: the frequency of the answer will be given. It will include the graphs of the data.
- The misconception of the students: especially we will compare the answer with our expected results and previous works.
- The discussion of this question in detailed. Mainly we will discuss the reason and possible outcomes of our findings.

RESULT AND DISCUSSION

Forced-open question was asked in methodology, which was modified for the shape of the Earth by Vosniadou, Skopeliti and Ikospentaki (2004)[8]. Then there was added a similar question about the relative position of Sun, Earth and Moon. The students draw pictures related to both the earth's shape and the relative position between sun, earth and moon. All of these questions has been investigated and counted. Each answer given to 8 questions was counted into the appropriate category. There were two classrooms that consisted mostly of 40 students in each classroom. There are a total of 78 students responding to the open-ended questionnaire, and there are 4 students interviewed. The adapted questions were asked to the students before introducing the open-ended questionnaire to see if the questions are appropriate for our students. Some of these students have been picked because they obviously have common misconceptions and the other one does not seem to have any misconceptions. The example of different answer, especially misconceptions, has been discussed in the categories that have been created for each question. Misconceptions in students' drawings were examined and presented. All these examinations were supported by the interviews with students who were chosen according to their response to the questionnaire to make an interview. It was seen in the studies that the students had problems creating their own original answers, could not make sense of the concept of gravity and thought that the shape of the world was like a cd.

3.1 Question Number 1

3.1.1 What Is the Shape of the Earth, Can You Describe It?

The reason of the first question is to begin with the definition of the students that they make by themselves before passing them to the next question. Also, the question is widened with the description of the shape of earth, because of that drawing could help them to explain more deeply.

This question is essential for the revealing the misconception in the beginning. Already some of them show their misconception by only giving the name of the shape that they think. In this question there are ten different main title for the shape of the earth which sphere are, round, ball, circle, ellipse, oval, cube, egg-shape, geoit and flat.

In 5th grade curriculum, now the students become a familiar with the shape of the earth. Instructions are giving this information as sphere and similar with balls' shape. Geoit should not have been mentioned in 5th grade. But it mentioned frequently as in observed.

Table 3.1 The distribution of the answer of the students to question 1

What is the shape of the earth, can you describe it?		
Shape of the Earth	Number of answers	Percentage (%)
Sphere	40	34,48
Round	29	25,00
Ball	22	18,97
Circle	12	10,34
Ellipse	3	2,59
Oval	3	2,59
Cube	2	1,72
Egg-shape	2	1,72
Geoit	2	1,72
Flat	1	0,86
Sum (N)	116	100,00

As in showed in the Table 3.1 the allocation of the answer has a greater value in sphere, in contrast smaller number in flat shape of the earth. The total number of the students is 77 however when you add those number in the table you will find bigger number than total, since there were some students who give more than one answer.

There are 116 answers instead of 77 individual answers. So instead of putting them into one label, distributed them to more than one label. sphere, round and ball. In total their percentage is 78,44, but in the other their percentages are 34,48 25 and 18.96.

There are common misconceptions with the previous study [7], [8], [19] in this field such that flat-shape of earth and disc-shape of earth. However surprisingly, there are some students who says that the shape of the earth is cube and looks like egg. Their percentage is not significant, nevertheless it is bigger than one, and it is 2,58% for cube and 1,72% for egg-shape. More surprisingly there is huge misconception about the definition of sphere.

The question is not for the reveal the flat and disc shape of the earth this soon. Most of the students know the sphere shape of earth but they cannot imagine, or they cannot connect this information with their real life. Most of the students describe their world by their observation which tells them the shape of the earth is flat. Instead of saying flat these students show their thought in their drawing or more emphasized in the answer of forced questionnaire. However, they already show their thought by only asking them what the shape of earth is. It is so important that instead of scientific clue, such as photograph from space, the students tend to their observation, so the teacher should make more emphasis on daily life example in their course instead of scientific proof that is not mean to anything for the students.

These are some of the picture that will show the example of the shape of the earth that the students drove them.

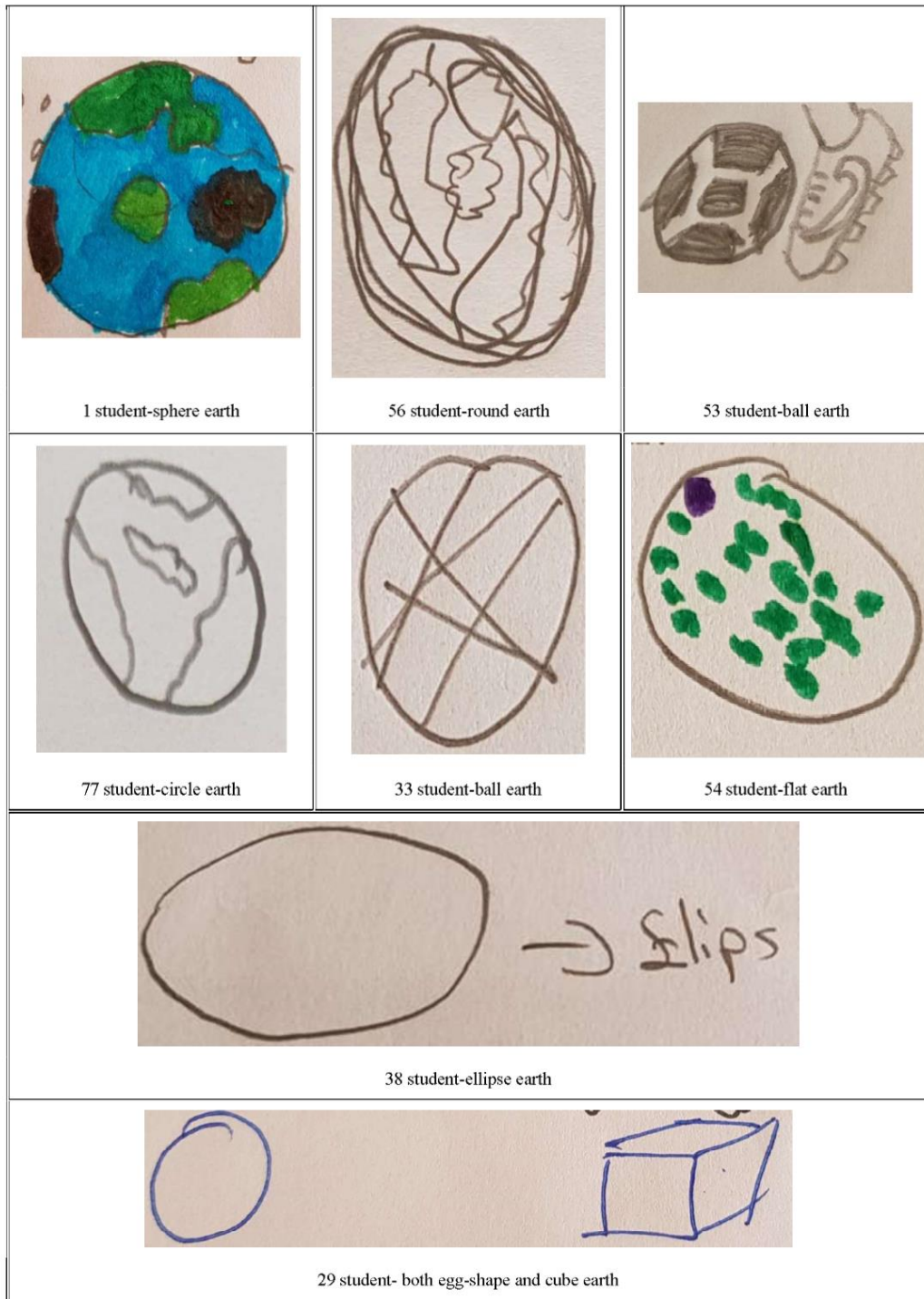


Figure 3.1 Student answer for 1st question

These are more interesting answer of this question. Also, one of them is clearly think that the earth has both cube and egg shape. The 29th student should be in a very confused situation.



Figure 3.2 29th student- both egg-shape and cube earth

Probably, the 29th student knows that the shape of the earth is in three-dimension, however it has still flatness like in cube. Yet it is difficult to understand the relationship between egg and cube. Probably the cube comes from his/her daily life experiences. The egg comes from instruction that has been given in the lesson. The shape of the earth is defined as a geoid which should not be given to 5th grade students. However, the teacher should have mentioned this and to be able to make more sense, this shape is likened to an egg. Even if we were linked to the egg, we would have been shown a side view of an egg instead of a top-down view. Because of this different answer, this student was interviewed to examine the misconceptions in more detail.

The utilization of analogies specifically has been extremely successful in inciting students to assemble understandings either through hands-on associations with substantial assets [75] or by making reasonable connections with recognizable items, situations, or occasions [76]. Guerra-Ramos [77], has depicted the numerous points of interest and impediments related with utilizing analogies to show science and has given a few recommendations to science instructors when choosing to utilize analogies in their study hall. The low recurrence with which science educators use analogies in their study hall is that as it may, keeps on being a worry and Brown and Salter [78] have proposed that the test for educators may be connected either to their absence of certainty with the methodology or then again to an absence of information about analogies when all is said and done or potentially the decision of similarity for a specific use. Notwithstanding the archived low recurrence with which science educators use analogies in their ordinary instructing, when met in work of [79] and later in an investigation of [38], science instructors were of the view that they utilized analogies frequently in their instructing and that in these occurrences they had utilized the analogies properly.

Teacher: Now let's start 29th student. We asked how to do you know the shape of the world. You said he looks like a cube and an egg. And you said there are pictures of the earth in most places, so it has egg shape. What else can you tell? A little sharp at the top like in egg?

Student: The tip is a bit sharp.

Teacher: Is the upper side sharp?

Student: Yes. The lower side is a little more sharp than upper side.

Teacher: You write a cube on the answer. What kind of shape is the cube?

Student: As follows. (pointing the shape that she drew)

Teacher: Hu. Sphere. Look, this cube. Is that like a ball you mean?

Student: Yes.

Teacher: You said that this was the case and I saw the picture of the world in many places. You said astronauts. That's your explanation. Any other evidence?

Student: I saw it on the maps.

Teacher: On maps. But for example, this is a map, but I cannot solve the round.

Student: My teacher is saying this in many places.

In this conversation the instruction guides and orient the students, since the students is not enthusiastic to talk, so the teacher instruct more than usual he/she should it. It should be noted that the teacher is the science teacher of the student for the all 5th grade.

This student has been chosen on purpose, since there are two students who gave the answer that the shape of earth is egg. It is slightly different from other answer. However, we can understand that the student mean sphere shape with saying egg according to the interview.

In addition, when the students try to answer the second of the question, we encounter with the same problem which student are not able to give satisfying answer for the explanations. They are forced give their own explanation for the question. Their reasoning is not sufficient enough to answer it. Because of that she simply answers that is that or I saw on the map.

Teacher: 38th student you said in the first question; The shape of the earth is a slightly trapezoid shape of the round shape. So that's ellipsis. What do you mean by that? You drew it there somehow.

Student: Yes, it's about the shape of this world being a bit crooked, but it's like a circle. This shape is called ellipse.

Teacher: Like an ellipse? Or like a ball?

Student: Like a ball. But for example, there are different balls. Such trapezoid balls...

Teacher: Did you compare it to American football?

Student: Yes

Teacher: Do you think of another name as an example?

Student: it's not coming.

In this passage the students define the trapezoid as an ellipsis. Here there is a misunderstood with the definition of some term. This was the unexpected misconception in the research. Although, it seems that the guided questions seem worse, it is seen that the student is more effective in removing the misconceptions.

The most different drawing is that 5th student draw 2 set is collapsed into each other as in math. It is not significant for the comment, since they are 5th grade students which cannot aware of some of their actions.

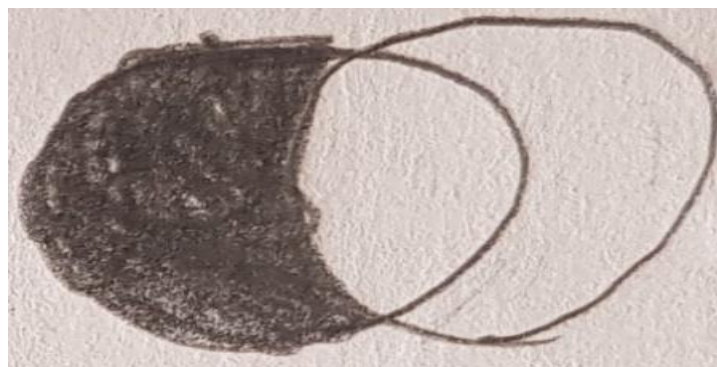


Figure 3.3 Set shape of 5th student

These three words means nearly the same with each other. It should have been examined that there are any differences between them, when the students answer with them. We

should look at the definition of these words and examine any cultural differences in Turkish.

Sphere means that a solid geometric figure 3.3 generated by the revolution of a semicircle about its diameter; a round body whose surface is at all points equidistant from the center [50]. When we look at the definition of the round, we encounter with that having a flat, circular surface, as a disk. In the definition of at English there is a difference between round and sphere, but some of the definition is still same for them.

Round has a meaning of surface which arouse misconception for us. However, when we look at the definition in Turkish, they can be used for another. Round means ball or sphere [51]. More importantly, the round and ball shape have nearly same definitions. Some of the students could think that whether the sphere and the round is same or not. In the interview of the 1st student there is an example of the another meaning of the sphere according to the kid.

Teacher: Now you call it the sphere of the earth. What do you mean by a sphere?

Student: My sphere is meant by my teacher, for example the sphere is blue, green. For example, blues show the sea. The greens show green things on the land and the brown plains.

Teacher: And how do you know that's the way it is?

Student: I think scientists have explored the way this is. They share them with pictures on the internet.

Teacher: So, you know from the pictures? Is there anything else that you've been told that you can hear?

Student: No

As in the first interview the shape of the earth is clearly understood by students, however they have a trouble with when they give justification. This is not a coincidence. The type of instruction that are made in public or private school has teacher-based structure. So, the students have hard time to give any example for their claim. They just only know the fact; they do not interrogate of what they know. They do not aware that the scientist even has more than one idea in particular subject. They think that there is only one truth and this truth must have been justified by some authorities. That means they memorize the

facts, so it is so hard to find their misconception. Maybe they cannot reveal their thoughts in their mind. So, it was wise to ask more than one question for the same topic. For this student asking more than one question does not change the results of what they know, but the fact that we are sure of it by asking more than one question.

In the research, 13 students among the students who wrote earth has a shape of sphere wrote the earth also has a shape of the ball. Besides, 9 students among the students who wrote earth has a shape of round wrote the earth also has a shape of the ball. That seems that the ball shape is more related to each other in sphere shape, moreover the research shows that the percentage of the number of the students who wrote round, and ball together is nearly same the number of the students who wrote sphere and ball together. Sphere, round and ball have probably meaning equal thing in the mind of the students.

Here, there is an example of the 53rd student who gives the answer of the ball as a shape of earth.

Teacher: How do you compare it to a ball? (your drawing of earth) Like an American football? Like a regular ball? Or Like a basketball ball?

Student: Yes, like a normal ball.

Teacher: So how do you know the shape of the world is like this?

Student: I have heard such things in my life before.

Teacher: What did you hear?

Student: I heard about it at school. In primary school or something. I don't know if it was a class 4. They were telling in the social studies class about the world'

Teacher: What's left of those lessons?

In this conversation, as we see that the student is sure about their belief of shape of earth. The student insists claim that his/her answer is correct. In particular moment she hesitates to give an example, but this could be an anxiety that he/she has. The instructor asked the shape of the ball to make confusion in the student's mind, however he/she still gives the right answer that she believes. The steady answer makes us believe he/she does not have a misconception at all. We can understand this by comparing the answer of the second and third question and so on.

3.2 Question Number 2

3.2.1 How Do You Know That the Shape of The World Is Like This?

In this question the answer of the students is examined with their scientific proof. This question is highly related to the first question. Even some of the answer of the students are same and mixing one and to another. For example, the answer of the second question is written in the place of the first question. There is more than one question about the shape of earth, since some of the students can memorize that the knowledge is taught in the lesson, but the other question can reveal the misconception of the students by asking more than one questions.

Moreover, the expected outcome is to reveal the thought of the students' answers how they are in shape. Even if some of the students answer that earth has sphere shape, they would answer the second question as a flat earth model. There is also example in the answer that students gave in second question.

Table 3.2 The distribution of the answer of the students to question 2

How do you know that the shape of the world is like this?		
	Number of the answers	Percentage (%)
Scientific source	35	40,70
From teacher	17	19,77
Picture of earth	21	24,42
Giving proof and explanations	7	8,14
Unable to classification	6	6,98
Sum (N)	86	100

Table 3.3 The rubric of the answer of the students to question 2

How do you know that the shape of the world is like this?

	Answer that has been classified	Answer that has been classified	Answer that has been classified
Scientific source	science magazines, newspaper, and any published material	internet, websites etc.	scientists or experts
From teacher	I heard in the lesson	our teacher said this in classroom	we studied the shape of earth is
Picture of earth	picture in science magazines, newspaper, and any published material	picture in internet, websites etc.	picture in course book
Giving proof and explanations	any kind of daily life experiences	explanation that had been talked in the classroom	example in the course book
Unable to classification	empty answer	drawing shape of earth or anything instead of giving explanation	writing about different topic

In the table of 3.3 there is a classification of the answer of the 2nd question. The classification was a hard work since the children gives tons of answer with their imagination. Before the table was drawn all the answer was read and this classification was made with respect of the students' answer.

There is one main misconception in the second question. This one is that the earth is round. I read in the book, but it is similar to a flat tray when walking. This is taken from the 59th student answer directly.

There is an interesting situation that the students mostly give answer that we know this from scientific resources in 40.7%. Even if they learn from their classes. Since they know that scientific evidences needed to be correct. So, basically, they are not clarifying their answer with example. This should be reason of teacher-based learning style. The students who used to teacher-based learning style are more tented to believe that teacher of some of one who is expert should know much better them. So, they justify their answer with the expert thought and comments such as scientific sources and school or any picture that placed in trustful magazine or internet sites.

Moreover, only seven students give scientific evidence and most of them is learned in the school, but this is a not bad things, since it means that the students adapted this understanding their previous learning. It shows the acceptance of the examples that they have been given in the class.

Teacher: You said that the shape of the world is like this. At sea, man finally goes to the horizon. Keep swimming, goes to the horizon in the end. Also, scientists have researched. How does it tell you that this is the shape of the world?

Student: Teacher, I read it somewhere. For example, face to face is coming to an end. For example, one can notice this by walking or walking on earth.

Teacher: How can he notice?

Student: For example, a round shape is created by walking. Like when you swim.

Teacher: I don't understand much. What do you mean by the horizon?

Student: You know, there's a line like that at the end of the sea. I'm talking about that line.

Teacher: And if he swims to that line, does he reach it?

Student: Well, maybe he can't, maybe he can't.

Teacher: What if he does? What will he see when he gets there?

Student: I have no idea.

Teacher: What if he doesn't get it? Will he continue to swim?

Student: If he does not reach, he continues to swim. He won't swim if he meets him.

Teacher: You said scientists researched. The shape of the world is round... Do they investigate this skyline again?

Student: Yes. They taught it in elementary school by teachers. If I remember correctly.

Teacher: What did they say?

Student: Here they talked about the horizon. They said the world was round.

Here the students answer the question of the “how do you know the shape of earth like this”. As a first reaction the students answer, “I read it somewhere”. Then change this answer to “They taught it in elementary school by teachers”. Students tend to expect all the knowledge from their teacher as a scientific information. Moreover, the teacher asks too many leading questions and that confuse the student bit more. Although these directions seem to be challenging, some studies have stated that asking too many questions is actually a positive attitude towards students' learning. A classroom with an efficient dialog is capable of creating a wealthy and profound understanding of ideas, promoting and expanding higher order thinking among learners and encouraging communication skills [52], [53], [54], [55]. Mercer and Littleton [54] suggest that teachers use four strategies to improve student talk quality:

- use high level thinking: encourage student ideas
- respond to student responses
- use open questions and
- encourage student responses before providing feedback.

Responding student's response and using more open questions is actually encourage the students talk a bit more on the topic.

3.3 Question Number 3

3.3.1 If You Keep Walking on a Straight Line on Long Days, Where Do You End Up With?

A person begins to walk eastward from Turkey will find itself where? This question is little bit long from the other question, since it is hard to understand for 5th grade students.

This third question is served with the same reason with the previous two questions that had been asked in the questionnaire. It should provoke the misconception of the students have more and more. More importantly, it is forced question, since it leads the students thinking as how the result should be. There is also big world picture which is 2 dimension that facilitate the abstract thinking of the students. 2 dimension of world picture was selected on the purpose of that increases the misconception in the students.

The students are not familiar with this type of the question. They are more familiar with the knowledge and comprehensive level in Bloom's taxonomy. This question may difficult to them, to eliminate these differences there were more explanation than the other questions.

Teacher: Let's pass the next question. Now I've walked for days, starting at some point. Then I come back to where I was. Why is that?

Student: Because the world is round, so that it looks like the sphere and wandering around again

Teacher: You said you'd come to the same place. But do we say the world has an end? You said you didn't.

Student: I don't think so.

Teacher: What is the reason?

Student: Because the round has no edge, no corner.

There is no doubt in this conversation that the student does not have any misconception about the shape of earth, since she said the round has no edge and corner. This answer makes easier to understand the answer of that the earth has egg shape.

Table 3.4 The distribution of the answer of the students to question 3

If you keep walking on a straight line on long days, where do you end up with? A person begins to walk eastward from Turkey will find itself where?

	Number of the answers	Percentage (%)
Sphere	65	85,53
Flat	1	1,32
Unable to classification	10	13,16
Sum (N)	76	100,00

There is only one student who has misconception in this question. There is only one student we perceive from his/her answer that the shape of the earth is flat. When we looked at the previous answer, we can clearly see that he/she answer the first question as shape of the earth is sphere, however in this question he/she changes answer to flat earth. As same as other examples the student interfere the answer by looking his/her previous daily life experiences. He/she said that when we go further though the eat, we will end up with the horizon. Horizon in this part means that the shape of the earth is flat, because there is end. However, horizon is an end that we cannot reach. It is kind of endless linear distances that earth have. This child has a trouble with the imagination of seeing earth is sphere. Probably his/her daily life experience says so.

Another student who gives different answer from the other says that he/she will end up with South Korea, since he/she wants to go there. He/she wants to cut down his/her journey to there. The answer evaluated in irrelevant answer, but it says too much from answer. Although, this answer of the question off the topic, his/her answer to the first and fourth question can show he/she does not have misconception of shape of the earth.

In the interview of the first students, there are different concept arises such as; horizon.

Teacher: You said this to the continent of Asia - South - North America. Why did you write them?

Student: I don't remember him.

Teacher: I mean if you mean to reach the horizon, or you can walk here, for example, to see the Asian continent, then somehow come to North America.

Student: Yes, it is.

Teacher: Then he comes by turning.

Student: Yes.

Teacher: Why is the world coming back?

Student: Why can he come back there? He is a bit closer to North America and North Asia

Teacher: Where are they close? Is he near here?

Student: I'm stuck. How did I do that. I think I mean the horizon.

Teacher: And what is it like to call a horizon?

Student: My teacher is infinite.

Teacher: Does it have no end?

Student: Yes, my teacher. For example, in the sea, I don't know, my teacher may be infinite. My teacher is a line between the sea and the world.

Teacher: We call him the skyline. Let's say you started right now, you walked, walked for days, walked, walked. If you came in front of you on the mountain, you couldn't stop you. You continued. Can you reach the last horizon?

Student: No teacher. Because it is infinite.

Teacher: You can't reach it either. Does it always stay in front of him?

Student: Yes, my teacher.

Teacher: You always see the horizon.

Student: Yes.

Teacher: There is a sea. A skyline towards the end. Well, let's say you've gone to the horizon. Then, what will happen?

Student: I never thought of it.

Teacher: So, what could be behind it?

Student: Behind the clouds, the world, like how to say? For example, because the sky is separated by the sea behind the sky maybe. It could be the sea.

In this conversation, the understanding of concept of horizon surprisingly interesting and exciting. Basically he/she understands that there is no end of earth, since does not matter how far away go, you can still go exactly like in sphere bodies. He/she use infinite to define the edge of the earth. Even he/she does not use edge word cause he/she truly believe that there is no edge or end of earth. This is a strong evidence that the student admits the earth is in sphere shape.

3.4 Question Number 4

3.4.1 Is There an End to the Earth?

This question is to stand on more the subject of the size of sun, earth and moon. In addition to that this question is a kind of last question for the shape of three objects. Unlike the first question, in this question the students can give answer in two possible choices which are sphere and flat. Maybe this question can eliminate the unwanted answer in the first questions, such as egg shape and elliptic.

Students in the 5th grade program are now familiar with the shape of the world. The instructions give this information in a global manner and similar to the shape of the balls. The geoid should not be listed in the fifth grade.

Table 3.5 The distribution of the answer of the students to question 4

Is there an end to the earth?		
	Number of the answers	Percentage (%)
No, there is no end	61	78,21
Yes, there are end	13	16,67
Unable to classification	4	5,13
Sum (N)	78	100,00

The allocation of the answer has a greater value in sphere, in contrast smaller number in flat shape of the earth. Here, the answer which contains misconceptions moved to the flat surface earth. That decreases the misconceptions in the first question's answers.

One of the most encountered misconceptions is that horizon is an end of the world, so they say that there is a horizon in the end instead of cliff.

In this question, students thought that everything had an end in the earth as well as an end. Therefore, they often seem to have made more mistakes than a flat earth. For example; one of the students wrote that there are three part in the earth. One of them is beginning, the other one is middle and the last one is the end.

3.5 Question Number 5

In this question (figure 3.4) there is a picture of the earth which is seen form space or moon. There are also two arrow one of which shows somewhere in the north part of earth and the other one is shows the somewhere in the south part of earth. Moreover, the question asks can people live here?

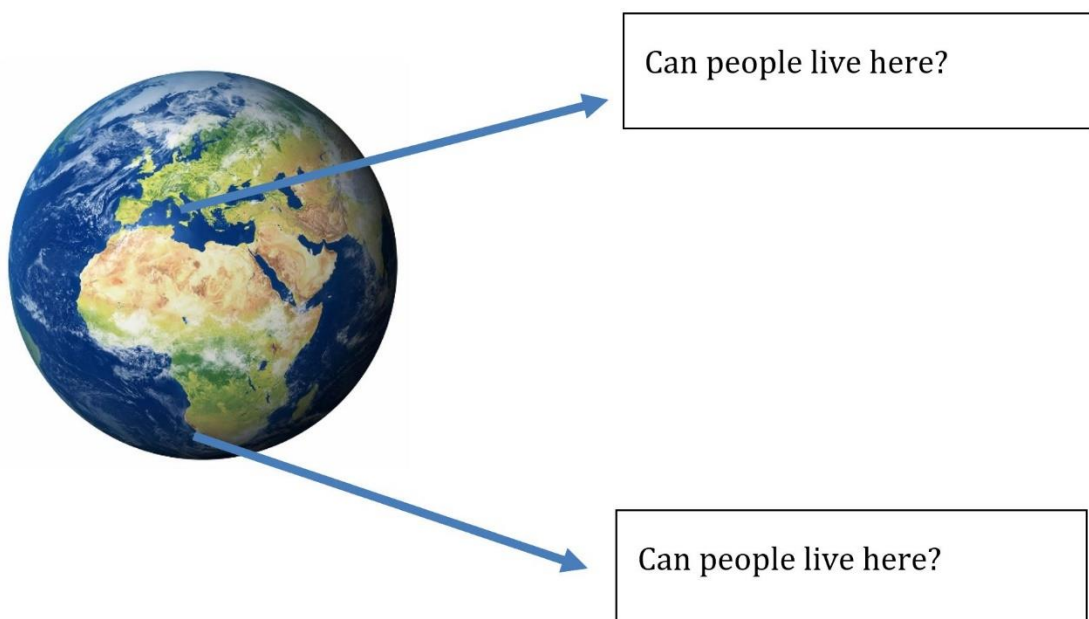


Figure 3.4 The shape of the 5th question

The purpose of this question is highly related to the gravity of earth. With respect to gravity, the shape of the earth has been questioning thought. If the students do not get

used to the idea that the shape of the world is a sphere, they think that people may fall to the ground in the southern parts of the world where they are not familiar with it.

The gravity is a subject of 6th grade, so the students only heard word, but they are not aware of the meaning of the gravity. Of course, in their daily experiences they are faced with the concepts. Surely, they know the gravity. In this question I want to see how they combine their daily knowledge of gravity to their concept of the shape of the earth. In addition to that the subject of gravity force is moved from 6th grade to 7th grade the next year of this research had been made.

In this question the misconception of the students is caused by the question itself. Living was a wrong choice. The students understood totally different the researches investigation. There are only five students who gives the flat surface earth answer among the students who understand the question in wanted. So, it is hard to say the misconception of the students. This question is irrelevant to the aim of the research. It is still worth to interpret the comment of the students.

The question is incomprehensible and confused. For the suitability of the questions, the questionnaire previously studied with a student. There was no problem with that student. But the fact that more explanations were made when going through the questions with a single student may have led to the omission of this question. Questions beforehand reveal the need to work with a larger group of students over the questionnaire. The question given in the question may be confusing. The question of whether it can live there or not that cause thinking of the necessity for people to live there. It is not understood that people do not stand upside down in the lower part of the world due to gravity. I thought this question was a general problem when I was teaching, and I thought that this problem showed that the shape of the world was not fully understood.

Most of the students wrote that in the upper part of the earth there is land, so people can live there. On the contrary the lower part of the earth which is showed with arrow there are no land and so there will be no sign of life. However, in the lower side of the earth which is pointed with arrow still has a land. The picture is ambiguous itself. In addition to that, some of the student gives the answer that people cannot live at the sea, because they do not have gill. Somehow, they connect to the science lesson with their answer,

however they get far away from the intended subject as well. Such as in the interview of the 5th student.

Teacher: Now we have a question to answer. I think you missed that note. Let's start here from Turkey. We followed the line and walked for days. We walked, we walked, we walked. We should be on board. Okay? If this plane goes, if he goes, where to go?

Student: My teacher first sees a sea around. Maybe you can see part of an island but that is very rare. Straight sees a sea.

Teacher: Do you have anything at the end of this sea?

Student: No

Teacher: Can he go to the end of the sea?

Student: My teacher can be an island. There may be an island.

Teacher: Well, let's say you're out of the sea. There's one more. Then you went again. So, he can't leave?

Student: I can go.

Teacher: Will it be a sea again? Is there going to be a sea?

Student: Can be at sea, on small islands.

Teacher: Okay, he came to the islands. You have exceeded the candidate

Student: Can go forever.

Teacher: I always have such sea. There's no island.

Student: Yes.

In the beginning of this conversation the student mention about the land, such as island. He/she believes that when someone began to journey, he/she needs to reach somewhere. He/she can understand that this question is all about a someone who wants to travel somewhere else. Then the instructor leads to the student to aim of the question. Basically, paraphrase's the question again for the understanding of the students. After that even if the student says how long he/she can go forever, he/she does not seem convinced.

Teacher: You said the world has no end. Yeah, he could live here. Because there's life there. Yes, he can live here too, because there is life there. What did you mean by life? What did you think?

Student: For example, if the world is a very cold place people can live there. It is a very warm place though there are also people who can live. I was seeing documentaries or somewhere else.

Teacher: Well let's not look too hot or cold now. For example, this is the top of the world, here is the below ... If there is a person standing here, can stop?

Student: Yes, teacher.

Teacher: Well, let's say that if there is a person there, can this stop?

Student: My teacher can stop.

The instructor and student here discuss the 5th question in the questionnaire. The 5th question one of the most difficult question to understand. Most of the student understand this question such as whether the location is suitable for the human being or not. So, the instruction begins with the answer of the students then turn the question into meaningful way. The instructor wants to learn the thought of the students about the gravity. So, students change his/her answer to yes, the people can stand at the southern part of the world.

Another example that has been placed in the interview of the first student.

Student: My teacher, this place is lighter. Land. Close to sea. But here it is all over the sea and it is dark.

Teacher: Huu you say dark here. Well, let me just say something; what if we say this is a little bit dark from the picture?

Student: it is from the picture.

Teacher: Or if we say all bright.

Student: If I say bright, he can live here. He can live there. But he can't live when they're both dark.

Teacher: Let's think about it. Let's say there's a man here. That's how it looks. Can he stand here with this kind of comfort?

Student: There cannot stand with comfort. Because there's a bit of sea there.

Teacher: Don't think that you're on the land.

Student: My teacher can stand on land.

Teacher: OK. Can he stand?

Student: He cannot stand.

Teacher: What happens when it stops?

Student: He cannot stand it because I like to say amaz

Teacher: No. On land again.

Student: Hui.

Teacher: Just standing upside down.

Student: How can he stand upside down? I think he cannot stop.

Teacher: If it stands upside down, what will happen to it?

Student: He can fall into a gap. To space.

The educators and understudy here talk about the 5th grade within the survey. The 5th question is one of the foremost troublesome address to get it. Most of the student get it this address such as whether they are is appropriate for the human being or not. So, the instruction starts with the reply to the students about the gravity. Unlike the first interview, the second student mix his/her answer in the questionnaire he/she gives different answer. Now he/she change her/his answer which show that there is misconception about the gravity. So, student alter his/her reply to know the individuals cannot stand at the southern part of the world.

Teacher: You say he falls to the floor. OK. Now we say people can live here. You said; Yes, because we know it is a reliable place.

Student: Yes. Because many places in the world are reliable. That's why.

Teacher: Then you looked at whether you lived somewhere in terms of reliability.

Student: Yes.

Teacher: Okay. Let's say; Would he live here? Does a person stop here? Or there was a skyline over there. Can I fall when I get past him? Or does a person stop here?

Student: I think he can't. Because it could be somewhere in the sea.

Teacher: No, not the sea. Totally black. But this guy is down in the world.

Student: Viable.

It can be seen that the 38th student sees the shape of the world as a sphere after the problem is solved. In the beginning teacher ask about the question of the student's answer to be able to get more accurate decision before to judge, since there was a problem at the beginning the question is not clear for the students because of the lack of gravity concepts.

Some of the students wrote that question upper part is so hot to live or so cold to live. This also shows that the students do not know how the climate of the southern part of the earth. They are unfamiliar with that part of the world. By looking at the picture, they are mostly guessing.

One of the strange answers that mentioning upper side of the world, people can live here, since there is industry. There should be one explanation for this. The arrow shows the European part of the world, on the contrast the lower side of the world which has been pointed with arrow is an unknown place for the students.

There is also one answer says that this is forest area, since it seems green. So, we can understand that the map of the students is adequate for this question. Such unrelated and irrelevant answers show that the 5th question is the wrong one to ask.

Teacher: We said people can live here. You said you could live. Why did you say that? (they are talking about 5th question)

Student: Because it is right here, because it is green there is no sea. But they can live in greenery.

Teacher: Why didn't you take that?

Student: because there are more whiteness places there. I don't know what there in white place is.

Teacher: A little bit like a desert. Do mean that?

Student: Yes.

Teacher: Why did you say you can't live in the desert?

Student: Because my teacher there is nothing. There's a tree. They don't know exactly how to live there. They don't know how to live in the desert.

Teacher: Hui. You're saying life can't be because it's hard. Well, let's do this, if there's a person here, can he stop without falling?

Student: Can stop.

Teacher: Well, if there is a person here, can he stand the opposite, without falling?

Student: None. He cannot stand.

Teacher: Can't stop Okay. What comes to it?

Student: Fall. It falls into space.

As in the previous data, the student is comfortable the knowing shape of earth, however the gravity concept is new for them. In the curriculum the gravity is subject of 7th grade and is not covered in 5th grade, so it is normal to students are not able to answer. Also, they are not

Teacher: What we have done here. If you keep walking on a straight line for days ... It's actually liked your swim on the horizon, isn't it?

Student: Yes.

Teacher: What did we write, as an answer? In other countries, the Pacific Ocean always has its horizon to the end. So, there's always a horizon?

Student: Yes. I think it's like that.

Teacher: You said that there is a horizon at the end of the world.

Student: Yes. When I say the edge, I gave the skyline as an example.

Teacher: Then can we say to the end of the world: There is a sea. At the end of this sea there is a skyline.

Student: Yes

Teacher: But what happens after you cross here?

Student: For example, I think it's like turning upside down.

Teacher: Like, for example, that sea. Think like I'm walking on the sea. I went, I went, I went. There was a skyline over there. Can I fall when I get past it?

Student: Could be. Maybe he can turn around. It either falls or reverses.

Teacher: What is it like to turn upside down? Are your feet in the air?

Student: May I swear. But I think it falls with a great chance.

Here, as before, the teacher's guidance leads to misconceptions. According to his/her previous answers, he/she has a globe-shaped world perception. Now, the student thinks that he/she is going towards the end of the world when, or he will turn upside down as if he/she were turning a book page. At least he/she thinks it will reverse, taking into account the presence of gravitational force.

3.6 Question Number 6

3.6.1 Can You Show Me Where the Sky is on the Picture by Drawing?

In this question, the main aim is that the reveal the misconception if the students have misconception about the shape of the earth one more time. The shape of the earth has been asked more than one question, since the previous researches provide more options about the shape of earth. Also, they engage clue to ask appropriate question. It is hard to find research about the misconception of the size of sun, earth and moon and their position relatively to another, so the question is predominately about the shape of the earth. Drawing sky is one of the challenging questions which is related to the shape of earth. When we ask to student draw sky most of them visualize the sky according to that they raise their head and draw what they see. However, if the student does not have the misconception about the shape of earth, he/she should draw the sky in 3-dimension. There should be sky at the top of the paper that the student draws on as well as, they should draw the sky at the bottom of the paper.

At the point when the students come to fifth grade, they definitely know the state of the Earth is comparable with round, yet they do not learn earth has geoid shape. From that point the student should know that the earth has geoid shape should include a sky which is not only the top, but it should be all over the place.

Table 3.6 The distribution of the answer of the students to question 6

Can you show me where the sky is on the picture by drawing?		
	Number of the answers	Percentage (%)
Cloud	39	37,86
Spaces/Satellite	30	29,13
Only top	31	30,10
Day/Night	1	0,97
Unable to classification	2	1,94
Sum (N)	103	100,00

There are 39 student who draw clouds on their paper. However, there is only one student who draw the day and night when he/she draw the sky. Day and night come to one after another, so it recalls the roundness that as a conclusion drawing day and night should be placed in the sphere earth concept. There are also two irrelevant answer for the question.

Table 3.7 Intreparation of 6th question

Can you show me where the sky is on the picture by drawing?

	Interpretation	Interpretation	Interpretation
Cloud	common idea is flat earth.	common idea is sphere earth.	evaluated this answer with the help of looking at other questions' answer and other things in the drawing
Spaces/Satellite	common idea is sphere earth.	a perspective from the space instead of ground can mean sphere earth	evaluated this answer with the help of looking at other questions' answer and other things in the drawing
Only top	common idea is flat earth.	can be usual habit drawing sky as in the top of the earth	evaluated this answer with the help of looking at other questions' answer and other things in the drawing
Day/Night	can mean the sphere earth if the student think day and night can follow each other by turning the earth around itself	still can mean flat earth	evaluated this answer with the help of looking at other questions' answer and other things in the drawing
Unable to classification	drawing earth shape instead of drawing sky	drawing something else different from sky	writing answer or filling empty

The description of the answer to the seventh question is given in the table of 3.7. the classification was a hard work because the children with their imagination offer loads of answers. Before the table was drawn all the answer was read, and this classification was made according to the response of the students.

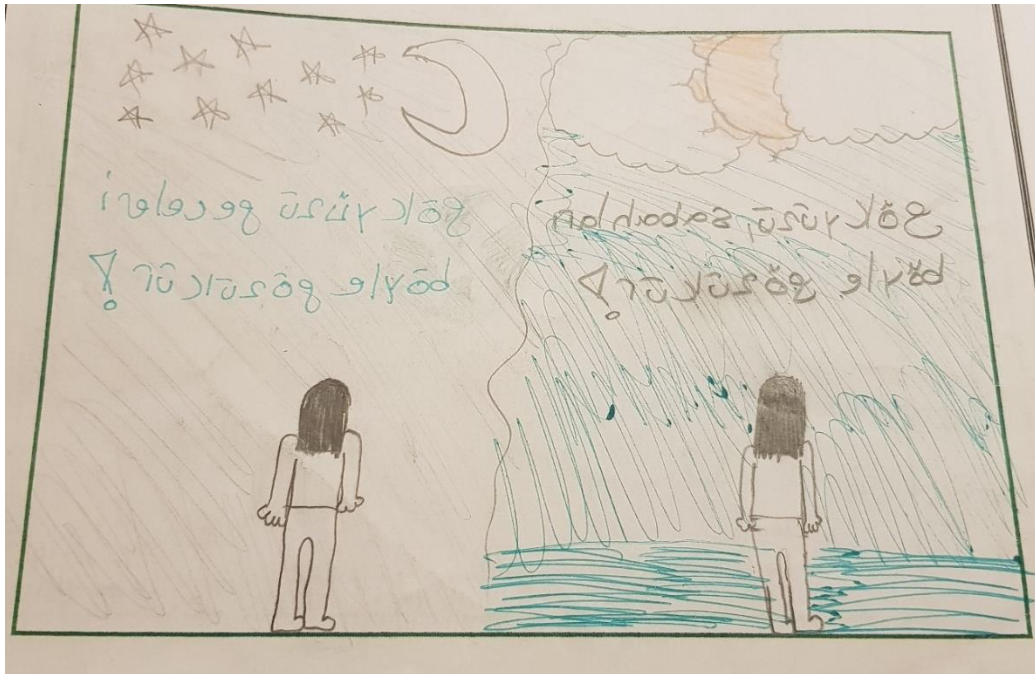


Figure 3.5 9th the student draw day and night



Figure 3.6 Example of irrelevant of 56th student

In the figure 3.6 the student might have drawn the sky as seen as in the picture of earth, however it should have been classified in irrelevant, since there is no different between the picture of earth and sky.

On top means that the student draw only sky at the top of the paper instead of the round sky. Spaces and satellite mean that the student draw the sky as a perspective from the space instead of ground. That is to say, the world for the place where he stands, and the atmosphere becomes extra-terrestrial space for him.

In this question most of the student draw the sky as a one dimension like in flat surface. As in the graph, there 31 student who draw the flat surface of earth. The answer is proven by the data of graph 4.1 and 4.4 again there is only one student who answer flat surface. According to the graph of 4.5 there is 13 incorrect answer. There are also eleven answer which is consist of ellipse, oval, cube, egg-shape and flat for first question. All of these answer shows the consistency.

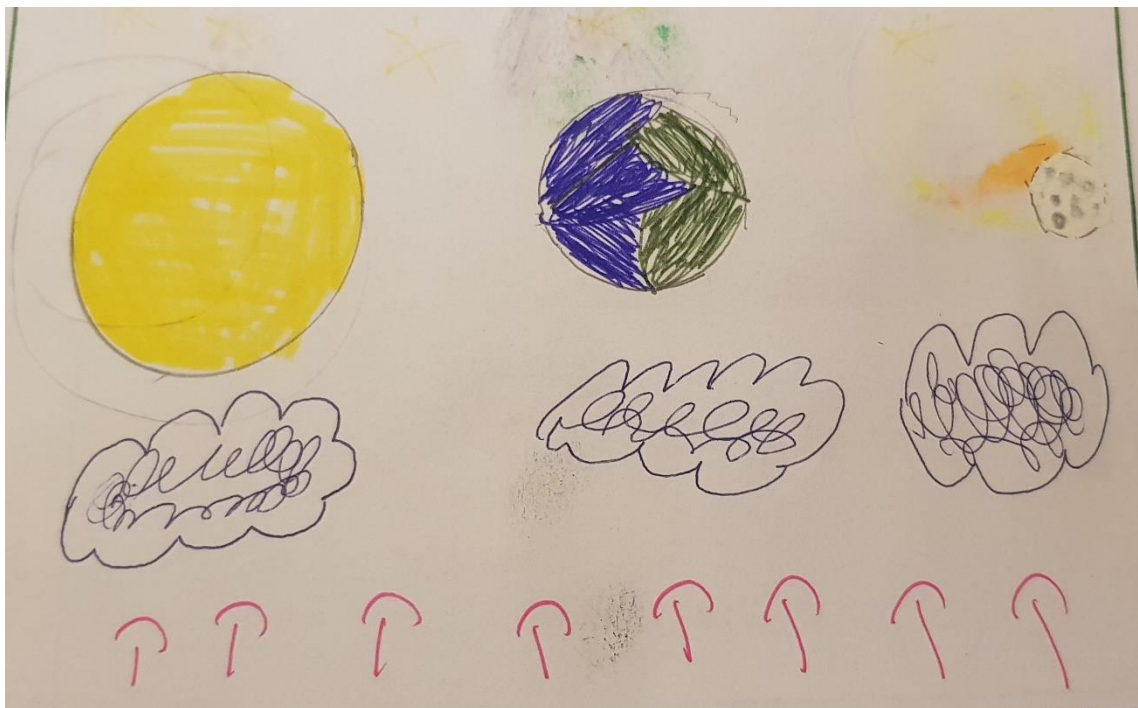


Figure 3.7 Clouds at the bottom

Most of the student draw their cloud at the top of the picture unlike the figure 3.7. In this picture the student decides to choose a perspective which is from space. There are also sun, earth and moon in one picture, so it gets disclose from the purpose of the question. Clearly, the student draws the sky under the effect of the other questions. The most

interesting part is that the student imagines the sky as a space but in the same time he/she thinks that there should be a cloud in one part of the sky. He/she could draw sky and above so that, he/she draw this picture as earth has flat surface, since the ground he/she live in at the very bottom of the picture then he/she draw the clouds after that he/she draw sun, earth and moon in upper part of the picture.

Teacher: Now you've drawn the sky here. What's in the sky? What are those?

Student: Star.

Teacher: What are these?

Student: Cloud.

Teacher: What are these?

Student: Moon.

Teacher: So, where are we?

Student: We are not here.

Teacher: Why?

Student: We don't have because I drew the air here.

Teacher: Hui. You say up in air. So, where's it up?

Student: Up the hill. To the top.

Teacher: Is one on top?

Student: No.

Teacher: Where else?

Student: Could be on the side. So, it can change.

38th Students drew star, some space object such as moon and clouds. The concept of sky is understood well. However, the concept of sky is all around us up and the bottom is not full covered. As in the previous discussion that Hannust & Kikas [4] held by the students actually thinks that the earth has a shape of flat and sphere both such as CD shape.

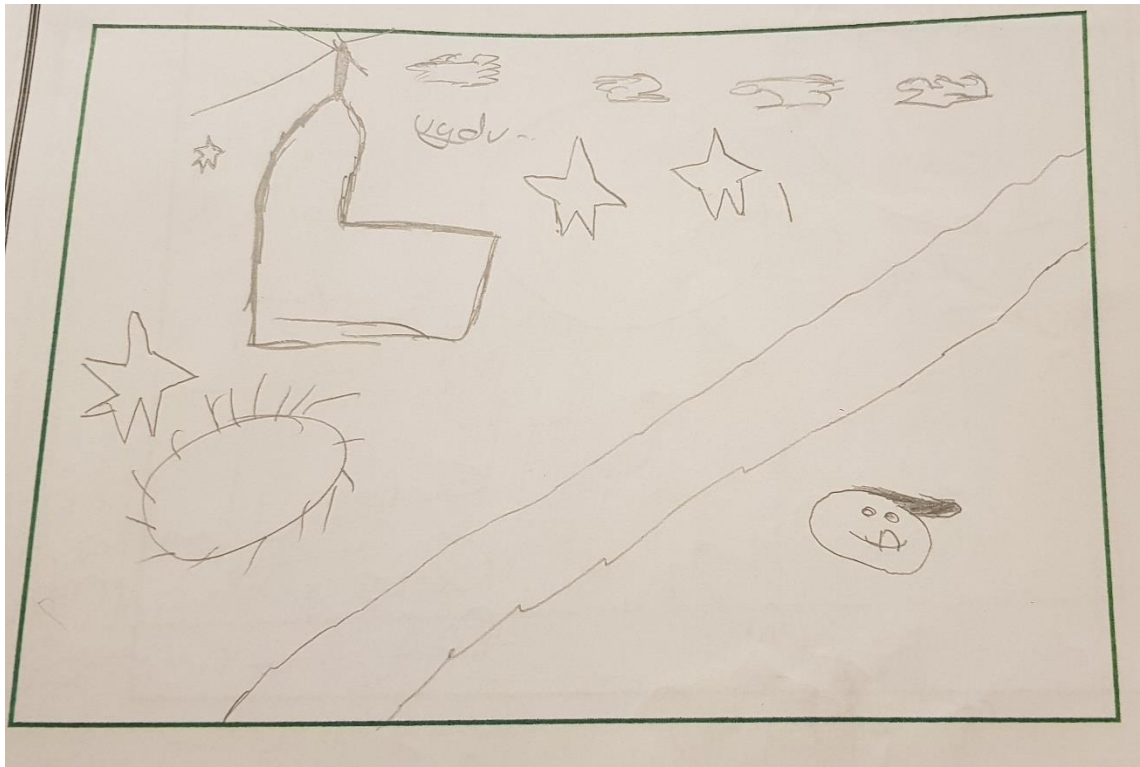


Figure 3.8 Cloud and satellite

In the figure 3.8, there is satellite, stars, clouds and sun. There is a big thing which look like a shape of house or church. The student wrote satellite nearby this shape. We can say that the student has a logic that the earth has sphere shape, the sky and space is drawn in diagonal position rather than at the top of the picture, it is different topic but the student understandably does not know what the cloud is or not.

Below is the part about the 5th question from the first student's interview:

Teacher: OK. What have you drawn into the sky now? We have sun. Those are cloud. You made this green. Grass. Has this always been the sky?

Student: Yes.

Teacher: You've drawn a line here. Why is that?

Student: I've drawn a line to show the sky there.

Teacher: You painted blue to make it clear that it was the sky. Here is the blue

Student: But my teacher, I made it so that I could clarify.

Teacher: That line?

Student: So yes. The whole blue place is the sky.

Teacher: From here?

Student: I did so, teacher. Actually, I could do that from there.

Teacher: So where is the sky exactly?

Student: My teacher is at the top. I got the earth down there, teacher. When we look up, we see the sky. But when we go out with a rocket or something, we see space. Actually, after some, we see a dark place. That's a space.

Teacher: Okay nice. Well, here's the sky. Is there a sky with them?

Student: I have a sky everywhere because my teacher is oxygen everywhere. But there is only one oxygen in the universe. There's only one air. So, when we look through the window, we can actually see the sky. We can't see when we look at the roof of a normal house. Or another job

Teacher: So, doesn't every sky with oxygen mean sky?

Student: My teacher, we cannot say sky anywhere. The sky is an open air.

Teacher: OK. Let's look at this now. Why did you say "moon"?

Student: Because my teacher is actually the smallest planet. I said the moon because it's smaller than the world.

First student

Teacher: Did you split it?

Student: My teacher, I got there. Then I erased it. To make it equal.

Teacher: How so?

Student: To make the sky equal.

Teacher: Hui. Just because you did it up there. Okay, okay. Is there sky in here?

Student: My teacher there is sky.

Teacher: But you're saying that I've broken it. I get that. You've separated it to draw it properly. But what are you trying to do anyway? You tried to make a sky up there. Is not it?

Student: Yes.

Teacher: You painted these blue. Is not it?

Student: I didn't think so.

Teacher: Is this the sky? Maybe not.

Student: My teacher is not the sky. Because I have a balcony with a friend in front of me.

Teacher: What's the tip of the balcony?

Student: My teacher doesn't mean the sky behind him.

Teacher: You can't look at the sky from the balcony?

Student: Yes. No teacher I look to the sky from the balcony but if there is no balcony behind the house it will be the sky but are because I didn't draw it 3-D.

In this conversation, there are more than one misconception, such that moon is a smallest planet. There is a misconception about the concept of satellite and the planet, however the research does not consist these concepts. But it is worth to mention that in the 5th grade the students in Turkey do not familiar with the concept of satellite and planet until 6th grade. These concepts are used frequently in the classroom without giving their definitions.

Another misconception is that “the sky is an open air”. From this sentence and the conversation, we can say that the student thinks atmosphere is sky. The concept of space is not clear for the student. He/she might think that the universe ends after the atmosphere or the space full of oxygen which is clear determination for the atmosphere.

3.7 Question Number 7

3.7.1 Can You Compare with the Following Objects According to the Size of the Sun, Earth and Moon?

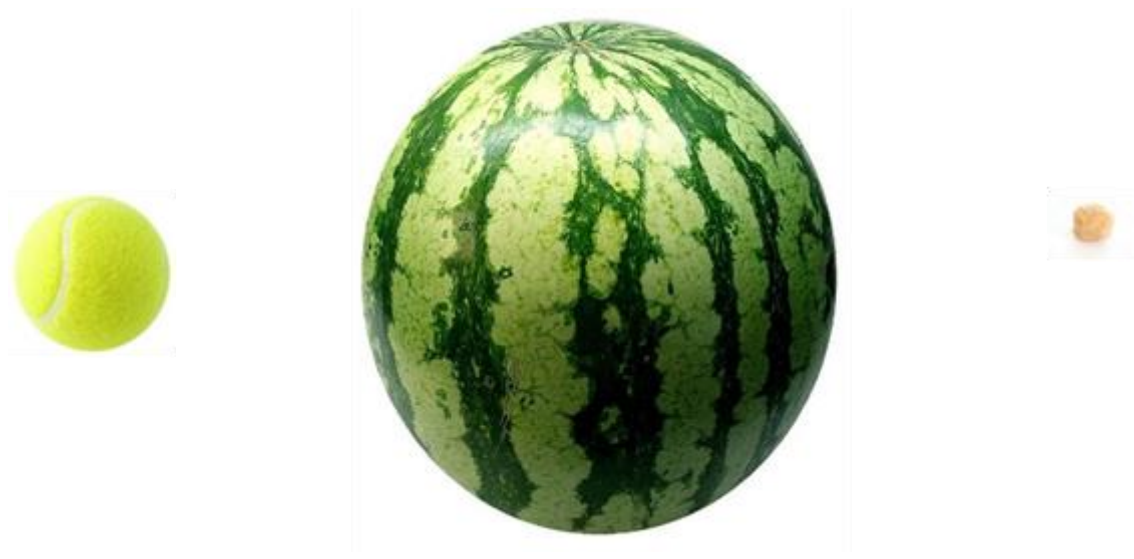


Figure 3.9 The picture of 7th question

The question is asked for understanding the children's thought of size about the objects. As well as, they can have misconception of the shape of the earth, they might have also misconception of size of sun, earth and moon. In this question the students are asked by the matching the size of sun, earth and moon to the familiar object that they already know. In the left side of the picture (figure 3.9) there is tennis ball which should have been matched with earth as a size. In the middle of the picture there is watermelon which should have been matched with sun. Finally, the chickpea as in the right side should have been matched with moon. It is an easy question in terms of both to answer and comprehend. Here there is an example of having a misconception about the size of these three space objects.

Teacher: What did you say to the world? Is this big?

Student: No.

Teacher: How is the sun?

Student: He is also great. It's pretty big. But I drew it as big as it was.

Teacher: As much as it is?

Student: Yes.

Teacher: What do you mean?

Student: So, this is now very big in the sun. It's pretty big. I showed him that much in the picture, but bigger than him.

Teacher: Okay, I get it. Looks like he made the map. You know, we're normally bigger than this in the world, but we're drawing smaller on the map.

The answer given by the student about the size of sun, earth and moon is highly satisfactory. "So, this is now very big in the sun. It's pretty big. I showed him that much in the picture, but bigger than him." With saying this the student show how sure with his/her answer with it. He/she emphasize that the size of the sun is much bigger, however she cannot find enough place to draw it well. In his/her drawing the size of the sun, earth and moon seems adequate, since the sun drew bigger than earth and earth drew bigger than moon. To be correct more there should be significant differences which is hard to shown. Moon should be smaller than dot when we compare sun which can be drawn size of a watermelon. Again, the important thing the students need to understand that the size of the sun bigger than earth and the moon. Also, the size of the earth is bigger than the size of the moon.

As in this question the instructor of sciences lesson was doing tons of example for comparing the size of sun, earth and moon. Mostly, they use similar example with this 7th question in the questionnaire.

Table 3.8 The distribution of the answer of the students to question 7

Can you compare with the following objects according to the size of the sun, earth and moon?

	Number of the answers	Percentage (%)
Accurate in size	61	79,22
Unaccurate in size	7	9,09
Unable to classification	9	11,69
Sum (N)	77	100,00

There are 61 students who gave the answer of watermelon specify sun, tennis ball specify earth and moon specify chickpea. There are also students who does not give any answer to this question. They leave the question empty. There is also one student who gives only explanation, but not drawing or matching with the picture.

In this question it will be wise to differentiate the answer into the two group. One group should be the one who did mistakes in finding earth and moon size correctly. Since, there are 4 students who confused about the earth is bigger size than the moon. The second group should be the student who misinterpret the size of the sun incorrectly. The sun has a biggest size among them all for who understand the size of sun, earth and moon.

In group one who did mistakes in finding earth and moon size correctly there is one student who wrote correct explanation and draw in eight question might not have misconception in this part. Although the answer of 7th and 8th question is not matching the student could be made temporary mistake. As seen the picture in below the student first match the sizes of earth and moon. Then he/she draw the earth and moon size correctly in 8th question.

Teacher: OK. You've drawn a "moon" here. What does this mean? Hiiim. You said this moon. Why is that?

Student: the moon is a little smaller than the world and the sun. It's how it looks so big from Earth, that's how far away from us. That's why we can see big. But normally it's not that much. (He/she means that the sun and the moon seem equal from earth, it is because of their distances.)

Teacher: Let's look at this. Now you've drawn a moon. You drew the world. You painted the sun. I thought you said you compare your size, so you're a little moon.

Student: Yes, my teacher.

As we understand from this short conversation the size of sun, earth and moon is well understood by the student. He/she emphasize that the estimate of the sun is much greater, and the estimate of the moon is much little than any other bodies.

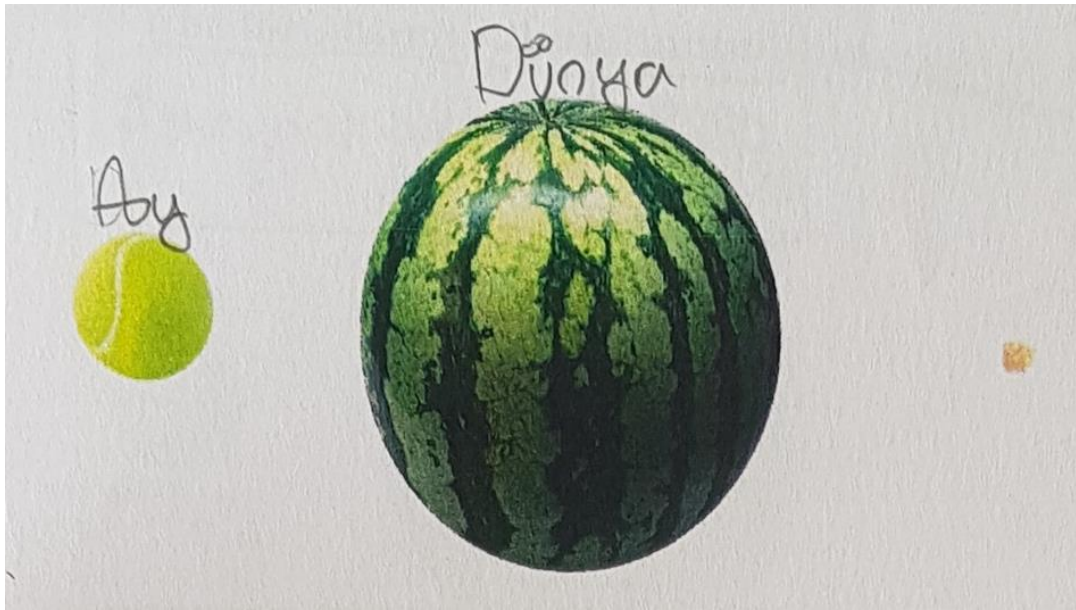


Figure 3.10 The drawing of 71st student

There is misunderstood in this matching, unless the student does not draw this (figure 3.10) this answer of 7th question could have been interpreted misconceptions. In the picture the student wrote moon at the tops of the tennis ball and wrote earth at the top of the watermelon, but he/she do not write anything at the top of the chickpea. He/she may have miss sun or cannot see the chickpea as well as.



Figure 3.11 The drawing of 37th student

In this picture, we can clearly see that the sun has the biggest size among them and the earth following. It is obvious that moon has a smaller size than earth. Although, both of the picture belongs to the same person, there is a contradiction between them. This confusion may not indicate the misconception. This one should be a minor error.

There is also one student who forget the earth. He/she wrote sun for tennis ball and moon for watermelon, but there is no sigh of earth.

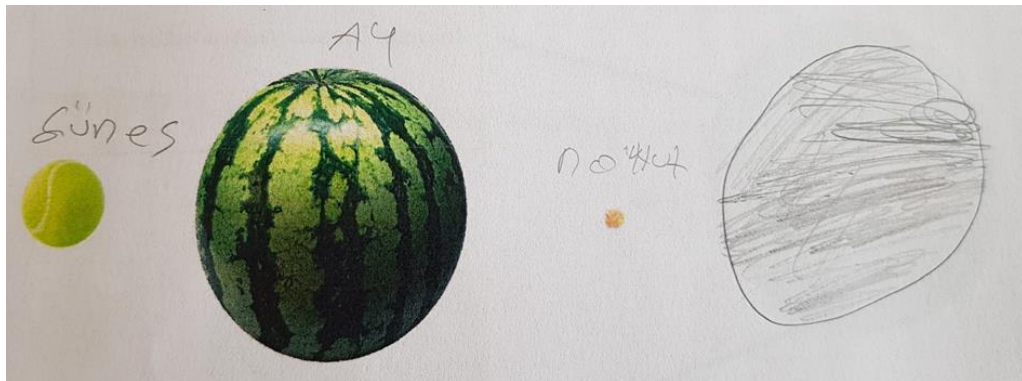


Figure 3.12 The drawing of 44th student

In the chickpea the students wrote chickpea in Turkish for course. The size of the sun and moon is enormously wrong. The bigger object is defined the smallest one moon and sun stood there beside the watermelon much smaller than. This picture clearly indicates that the student does not have logic of size of sun and moon when comparing them to each other.

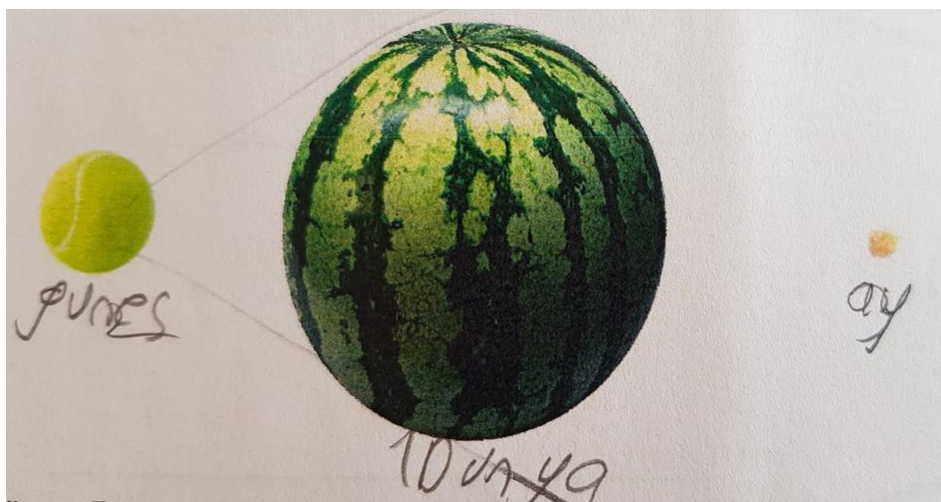


Figure 3.13 The drawing of 13rd student

In this picture the students wrote earth which is living place to him/her and there could be reason for this misconception for watermelon. He/she sees that the tennis ball should be for sun and chickpea is for moon. Only the size of moon is correct, however the size of sun is made smaller than it should be. The students probably define the world as their judgement, so the living place home should be bigger than any other space subjects.

Teacher: That's obvious. You made that sun. You made the world. You made a moon. So why did you choose the moon as a smallest?

Student: Because the sun is the largest, but the moon is the smallest.

Teacher: How do you know that?

Student: For example, they actually researched it and it may also depend on the distance, with the distances between them.

Teacher: How does it depend on distances? For example, is the remote one small? You want to tell it?

Student: Well, for example, the sun is farther away from the moon, so they can look the same size as the moon.

Teacher: Now that's how you draw the moon. I think what are those spots?

Student: Let me tell you if they're craters.

Teacher: Okay. Let's have another look. You drew the world. Did you notice the size here?

Student: Yes.

Teacher: So, is the world actually bigger than the moon?

Student: Yes.

Teacher: So, can I look at it and say it's great in the sun?

Student: The sun is the biggest.

Teacher: You painted black circles in the sun. What are these?

Student: I wanted to mention that there are layers.

Teacher: What are those?

Student: They're the lines of the sun.

Teacher: What's on these lines?

Student: My teacher had those lines, as I thought, in our doves. I looked like them. I think the lines of the spread of light...

Teacher: So, these are the lights that come into our world?

Student: Yes.

Teacher: Can something else happen?

Student: As something else...

Teacher: Is there all over this?

Student: I think it's all around

The conversation about the relationship between distance and size is a part of the lecture. The students recall this information when the talks are getting related to distance and size. So, the 38th students have a little idea about the subject that out of the lecture. They immediately think about something which has been taught in the classroom. There could be two main reason of it one they are not quiet used to say their interpretation or the interviewer was their teacher in real lecture, so when they see their teacher, they can be correlated with it.

3.8 Question Number 8

3.8.1 Can You Draw a Model by Considering the Size of the Sun, Earth and Moon and Their Distance from Each Other?

There are two aim for this question. One of them is to be sure of whether the students are able to draw the size of sun, earth and moon again. The other purpose of this question is how the students are going to draw the position of sun, earth and moon relatively. Do they able to draw the position of sun, earth and moon correctly?

In the previous researches there are not enough material that can verify the misconception about the position of these space objects. Most of them are interested in the size of earth.

In this research this question had been placed since there is need to reveal the misconception of the 5th grade students. They have in their curriculum of science of

Turkey. The position of the objects should be understandable for ten- and eleven-years old student.

Table 3.9 The distribution of the answer of the students to question 8 part 1

The number of students that accurate in size of the objects

Sun	Earth	Moon
67	62	63
Total number of the students is 78 (N=78)		

Incredibly there are too many misconceptions in this question relatively to the other questions. Although the seventh question was for the size of sun, earth, and moon, in the eight question is remark more misconception than the seventh question in terms of the size of sun, earth and moon.

Table 3.10 The distribution of the answer of the students to question 8 part 2

The number of students that accurate in position of the objects

Sun and earth	Sun and moon	Earth and moon
42	44	17
Total number of the students is 78 (N=78)		

The most challenging part for students should be the distance between earth and moon. When we considering to all the three objects, which are sun, earth and moon, the students able to understand that the distance between sun and earth is large, however when we put the moon into the equation the students miss the fact that the distances between sun and earth is larger than the distance between the earth and moon, so most of the time they draw same distance between earth and sun and earth and moon together.

Some of the students gives the approximately distance between these three objects in their drawing. Even they know the exact distance they draw the earth closer than it should be. I put these answers into the irrelevant title in the table.

There is also drawing which does not contain orbits, I also put these drawing into the irrelevant title in the table.

As in seventh question students were asked to give information about the size of sun, earth and moon in the eight question. It was for checking the previous answer of the students. There are seven students who did wrong of the size of sun, twelve students who did wrong of the size of earth and eleven students who did wrong of the size of moon. These finding is parallel to the answer of the seventh question, since the size of sun is understood more than the earth and moon itself. Also, the students are seemed more uncaredful when they are drawing the size of the moon and earth.

Even if the students can understand the subject that the distances between sun and earth is larger when we consider all three sun, earth and moon. Students miss the point that the distances between moon and earth is shorter than the distance between sun and earth. Some of the students make equal distances between sun, earth and moon.



Figure 3.14 The drawing of 61st student

In this picture the students wrote watermelon under the sun which is left side of the picture. In the middle there is earth and written soccer ball at the bottom. In the right side of the picture there is moon which is written ping-pong ball. The size of the space object

relatively true, however the students miss the point of that the moon and earth should be far away from the sun.



Figure 3.15 The drawing of 65th student

There are also the students who gives the digital number of the distances between sun, earth and moon, but they draw the equal distances between sun, earth and moon. There could be two reason. One of them could be they made failure to evaluation of their knowledge. In addition to that they cannot care about their distance when they draw the sun, earth and moon.

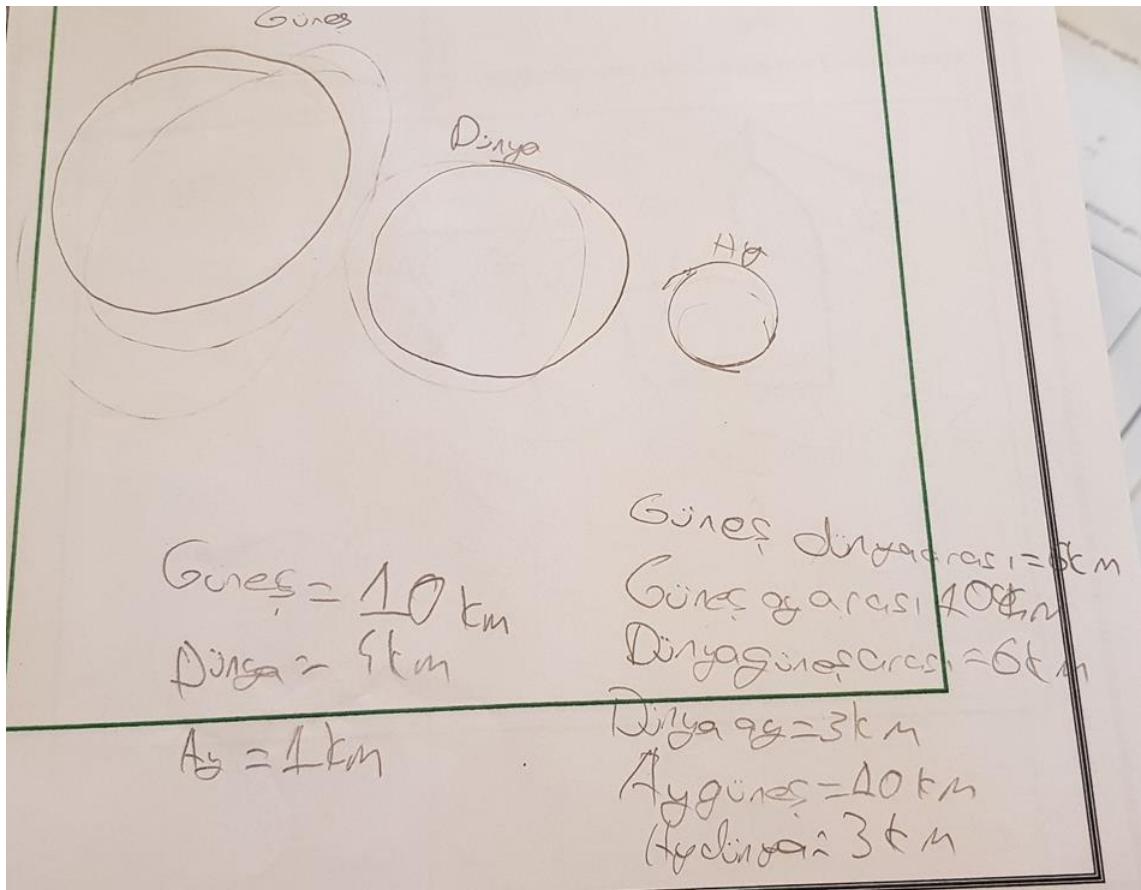


Figure 3.16 The drawing of student does not know the exact distance between the object

This picture is for more second reason. In this the student does not know the exact distance between the object but he/she gives the number according to himself/herself. For example; he/she wrote ten kilometers between moon and sun, since they are far away from each other. Of course, the moon gets into between the sun and earth, so moon is little bit closer than earth in sometimes. He/she wrote earth is four kilometers far away from sun and moon is one kilometer far away from earth. So, he/she made the point that sun is far from moon than the earth and earth is near to the moon.

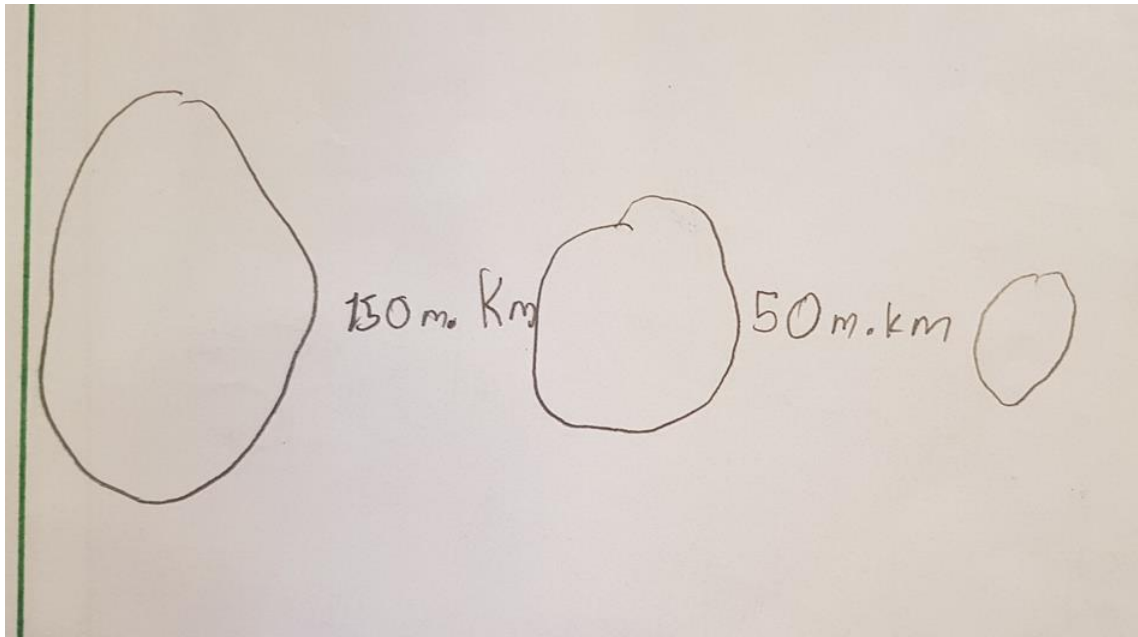


Figure 3.17 The drawing of another student does not know the exact distance between the object

The first reason is that they made failure to evaluation of their knowledge. This example could be example for this reason. In this picture it is not clear which one is sun, earth or moon. The students did not indicate this. So, we should assume that the bigger is sun, the little one moon and between them is earth. He/she said that the distance between sun and earth is 150 million kilometers and the distance between the earth and moon is 50 million kilometers. In short, he/she claim that the distance between sun and earth is larger than the distances between earth and moon. Further in his/her drawing it is impossible to see that. The distance between sun, earth and moon is nearly same. The interview with this student as in the below;

Teacher: How are these distances?

Student: I drew according to the distance and distance between the sun and the earth.

Teacher: Hui. These numbers show him.

Student: Approx.

Teacher: It seems to me that these two are the same distance.

Student: I did that one more step. I did this one step shorter.

Teacher: One step...

Student: There's a step between them.

Teacher: How is one step? What kind of distance did you think? A step you took.

Student: None. For example, it is like the step of something big.

Teacher: Hu. There're a million differences between them, huh?

Student. Yeah.

Teacher: Can you give any examples? For example, if I go from one place to another, I would say one step

Student: For example, like Istanbul to Ankara...

Teacher: Does this, for example, actually cover the distance between the two?

Student: Yes.

Giving the numbers between the space object is a very good way to enrich the drawing with scientific data. However interestingly, the students read this number with very short distance which is between Ankara and İstanbul. That distance is nearly 500 km only. So, million differences are something like the distance between İstanbul and Ankara in the students' mind.

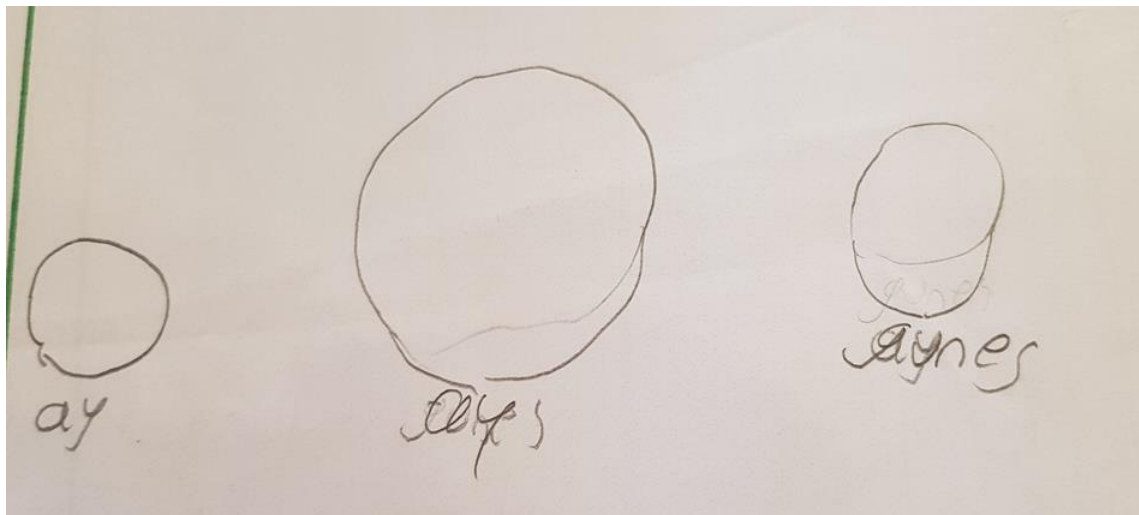


Figure 3.18 The drawing of irrelevant answer

Teacher: How did you make distances between them? You've put a little distance on this, for example.

Student: It is close to the world because the moon always revolves around the world. Even the sun is a little farther away. Because I've got a couple of planets right now. That's why I did.

Teacher: Okay, nice. Well, for example, what kind of length are we talking about?

Student: Solar system has an 8-9 planet around the sun. The earth is the 3rd planet. Because there are two planets between sun and earth.

Teacher: Venus with Mars. Pardon Mercury and Venus.

Student: That's why I drew a little bit away. Actually, I did something because the sun was a little bit distant from the planets.

To this point, instructor can understand the student's drawing correctly. When it comes to interpret the drawing, it changes people by people. 5th grade students can define their limit of paper according to themselves rather than using the wallpaper in once. So, this was change everything. For example, a student may place the sun at the one end of the page, on the other side of the page there can be moon. Between the moon and sun there can be earth which can be as much as possible near to the moon. The other students can only use small amount of space in the questionnaire paper, so that can lead the closeness between sun, earth and moon. Drawing is so incapable of showing the thought of the students. Such as this interview the student herself/himself says that there is a distance between them. Since there two more planet between sun and earth which is cause of distances. Moreover, there is an interesting point that the student cannot give any example of the distances between earth and moon which is understandable none one on the earth are not able to see or define such a distance in their real life.

Teacher: Are there long distances between this space objects?

Student: There is no long distance. If one of the planets is here, the other is there. But the sun is a little farther than them.

Teacher: Is the sun far apart?

Student: Not very different places. Very close to them. The planets are here in the sun.

Teacher: But if this planet is here, for example, is here on the planet?

Student: Yes.

Teacher: The sun is here.

Student: Yes.

Teacher: Can you give an example for this distance at all? It's like that.

Student: I can't give such an example.

In this question, we do not know that the student talks about the distance between the sun and other planets by thinking of the position of the sun in the whole universe, because the student seems like that the sun and planets are near them to each other, there are more spaces bodies in the universe. However, we should also consider that the student still has been making mistake in term of distance between the objects.

Student: Because my teacher, there is quite a distance differences between the sun and the world.

Teacher: Does the same distance exist between the moon and the sun?

Student: They have.

Teacher: So how is the distance between the moon and the world?

Student: I do not remember the distance exactly, but around 4.40.

Teacher: For example, if you give examples from daily life?

Student: Earth will be here if the month is here.

Teacher: Where is the sun?

Student: The sun is on these sides.

Teacher: Then the sun is in the middle, isn't it?

Student: Yes, my teacher.

Teacher: And what did you say about that? In the left hand

Student: Moon. World. Because my teacher revolves around the earth. The world is here.

Teacher: One minute. Now open your hand. (to able to see the paper.) Is the sun here? Or is he here?

Student: The sun is in the middle.

Teacher: Are you sure sun is in the middle?

Student: Yes, my teacher. This is happening. This is how it turns out. If the world turns like this... A little more on this side.

Teacher: I get it. Closer to the world. The moon is so far away.

Student: Yes.

3.9 Conclusion

In this chapter there will be conclusion of the study. Also, recommendation for another researcher who will work on related topic made. The main topic of the research, which is misconception will be explained in detail then, how the students make their alternative concepts with giving the example from the research' data and finding. After that there will be a discussion about what will be the reason for these misconceptions of the students. More emphasis will be placed on why the interviews provide evidence that students may have some misunderstandings.

Learning starts unintentionally when a child starts to build knowledge about a phenomenon while experiencing it in real life [56], [57]. This process begins before the students start to the school. This process even can be start in the belly of their mother before born. This process can be unstoppable, since the child wants to learn new something in every moment and he/she wants to make link between the previous learning that he/she has.

The new thing should be meaningful to his/her. To able to do that he /she have to make the connection between new learning and old ones. If the children make this connection unscientific way, they might be some misconception that they learnt. There is an example in a scene of lion king movie. The dialogue between Simba, Timon and Pumbaa goes like this; [58]

“Ever wonder what those sparkling dots are up there?”

Pumbaa, a don't wonder, I know.

Oh? What are they?

They're fireflies.

Fireflies that got stuck up in that big bluish-black thing.

Oh, gee.

I always thought they were balls of gas

burning billions of miles away.

Pumbaa, with you, everything's gas.

Simba, what do you think?

Well, I don't know.

Oh, come on. Give, give, give, give.

Come on. We told you ours. Please?

Well...

Somebody once told me that the great kings of the past are up there watching over us."

They talk about the stars and this dialogue is a good example of the misconception. Each character make prediction about the star with their previous knowledge.

This process happens same in the school too. The teacher lectures the new subject and the students make this new concept to the old one. However, as the lecturer the teacher has the big responsibilities of the shaping of the misconceptions. Misconceptions that were developed unintentionally prior to formal school education have often been supported by inadequate the way of teaching used in the classroom [59], [60], [61], [62].

There is also other factor which are not considered in this research. There are studies which says that knowledge provided in the textbooks [63], the use of everyday language or metaphors and analogy [64] and the experiences that students face with in their daily lives [65], [56] are common effect that misguide to the students into misconceptions.

In this research the main concern is about the misconception of the shape of the earth. The result from the research shows that among 116 answer there 3 wrong answer in the first question. This number same in the question three except there are 10 irrelevant answer for this question. In the question four there 13 wrong answer and 4 irrelevant answer among the all 78 answer. The second question was not an efficient question for revealing the misconception of the students. As a conclusion the data shows that the shape of the earth almost understandable for the 5th grade students. They can image the earth as a sphere object.

As for question second, we can observe that the students have a difficult time to answer such an open-ended question needs long answer and justification. In most of the answer the students say that they know the shape of the earth from the scientific sources such as internet, magazines and news. However, easily one person can understand that this scientific source is their teacher himself/herself. Most learners define their universe through their observation that informs them the earth's shape is flat.

These learners demonstrate their thoughts in their drawing and more emphasized in the forced-questionnaire response. They're already showing their thoughts, though, just asking them what the earth's shape is. It is so crucial that the learners tend to observe them instead of academic clues, such as photography from space, so the teacher should emphasize the instance of daily life in their course rather than scientific evidence that is meaningless to the learners.

In their education system the students hold in a position of the finding answer among the choice not just in the multiple-choice exams but the lecture in itself. They have a hard time to provide evidence for what they learn. As a proof of this claim that in the first question the two of the students give the answer of shape of earth is like egg, since their teacher told themselves that “imagine an egg which is tilted that what the earth looks like”. They give this answer to the first question after that they answered the second question (which is how you know the shape of earth like that) that “I know because scientist says that”. This should be due to the learning style of the teacher. Students who used to teacher-based learning style are more tempted to think somebody's specialist teacher should understand them much better. They justify their response with expert thoughts and remarks such as science sources and college, or any photo placed in trusted magazine or websites.

Another example of this situation is the ship example. The teacher begins with the question that what part of the ship we can see before coming from the sea. The teacher emphasizes that if the world were flat, we could see all parts of the ship at the same time. But since it is round, we see the ship's mast and then the body and the rest of it. Moreover, the teacher in Turkey says that the photography has been taken form space is a clear evidence that earth has sphere shape. This evidence is mostly written by students in second questions.

Cakici and Yavuz [66] suggested that the effect of constructivist-based science learning on fourth-grade students' understanding of matter is highly successful. The experimental group was taught using constructivist teaching practices, while the comparison group was taught using traditional teaching practices based on direct speech and a question-and-answer strategy as in our research. The results exposed that there was a remarkable enhance in achievement among the experimental group students in contrast to the comparison group. In particular, the teaching based on the constructivist approach appears to be effective in eliminating the misconceptions.

Another study shows that students who learned about the phases of the moon using the inquiry-discovery approach have better comprehension about the topic than the comparison group students [67]. The role of the teacher varies between the conditions. These variations in the way that inquiry-based teaching is defined have consequences for the inferences made in research syntheses about the effectiveness of the approach [68].

There also another point that the students have faced with problem the definition of some word is confused. In the interview four and three have this common mistake. The reason behind that the definition of sphere or round and circle is not well-understood by the students that makes hard to distinguish where the real misconception is in. In this research we focus on the misconception which is related to the science especially the earth, sun and moon subject rather than the math terminology.

The interview was a good choice to reveal those kinds of misconceptions. Gurel et al. [69] investigated all of 273 articles published from 1980 to 2014 in main journals and concluded that 53% of the studies used interviews, 34% employed open-ended tests, 32% multiple-choice tests and 13% used multiple tier tests (single, two and three tiers). To sum up interview is good technique that reveal the misconception in more appropriate level. Also, it gives more opportunity ask more than one question to the students and change your next question according to the students' answer. Instructor can make more understandable the answer by asking question more than one to the students to get satisfaction of the answer.

Moreover; France [70] state that teachers working to promote efficient dialog are also needed to have high-level questioning abilities. High- level questioning abilities might provide to reveal misconception to deeper sense. While educators spoke more often than

they indicated when building efficient dialog was suitable, further study showed that much of this teacher talk was actually used to scaffold the teaching of learners. The information disclosed that these educators used more open-ended questions than closed and asked a series of questions that prompted higher-order reactions to learners such as explaining, using of meta-analysis or applying there in science classroom. If the teacher used open-ended questions effectively in the classroom, the students would not have difficulty in providing information in these interviews.

Dialog is a method of investigation, unlike discussion, requiring a participant to reflect on their own ideas and those of the other respondents [71]. Dialog was shown to create students reasoning when used efficiently, leading to greater order thinking and academic gains [54], [72]. There is a question that arose whether, the teacher asks more questions badly affect the effectiveness of the interviews or is it the opposite. There are some of academic research that advocate the usage of asking question affectively to develop the student's learnings. A classroom with efficient dialog is capable of creating wealthy and profound understanding of ideas, supporting and expanding the thinking of greater order learners and promoting communication skills [52], [53], [54], [55].

REFERENCES

- [1] Major, J. S. (1997). *Heaven and Earth in Early Han Thought: Chapters Three, Four and Five of the Huainanzi*. New York: State University of New York Press.
- [2] Savin-Baden, M. and Major, C. (2013) *Qualitative research: The essential guide to theory and practice*. Routledge, London.
- [3] Hannust, T., & Kikas, E. (2007). Childrens knowledge of astronomy and its change in the course of learning. *Early Childhood Research Quarterly*, 22(1), 89–104. doi: 10.1016/j.ecresq.2006.11.001
- [4] Hannust, T., & Kikas, E. (2010). Young children’s acquisition of knowledge about the Earth: A longitudinal study. *Journal of Experimental Child Psychology*, 107(2), 164-180. doi: 10.1016/j.jecp.2010.04.002
- [5] Thompson, A. D., Simonsen, M.R., Hargrave, C. P. (Eds) (1996). *Educational Technology A Review of the Research Association for Educational Communications and Technology*, Washington. Retrieved March 29, 2019, from <http://bilgioloji.com/pages/fen/astronomi/antik/eski-yunanlilar-dunyanin-gunese-ve-aya-olan-uzakligini-nasil-hesapladilar/>
- [6] Eggen, P. and Kauchak, D. (2004) *Educational Psychology: Windows, Classrooms*. Upper Saddle River: Pearson Prentice Hall.
- [7] Nussbaum, J., & Novak, J. (1976). An assessment of children’s concepts of the earth utilizing structured interviews. *Science Education*, 60, 535 – 550.
- [8] Vosniadou, S., Skopeliti, I., & Ikospentaki, K. (2004). Modes of knowing and ways of reasoning in elementary astronomy. *Cognitive Development*, 19(2), 203-222. doi: 10.1016/j.cogdev.2003.12.002
- [9] Minister of Education Department, 2013
- [10] Minister of Education Department, 2017
- [11] Duffy, T. M., and Cunningham, D. J., (1996). *Constructivism: Implications for the design and delivery of instruction*, In D. H. Jonassen, (Ed.) *Handbook of Research for Educational Communications and Technology*, NY: Macmillan Library Reference USA
- [12] Ausbel, D. P. (1968). *Educational Psychology: A Cognitive View*. New York: Holt, Rinehart and Winston, Inc.
- [13] Novak, J. (1987). *Proceedings of the Second International Seminar: Misconceptions and Educational Strategies in Science and Mathematics*. Ithaca, NY: Cornell University, Department of Education.
- [14] Driver, R., & Easley, J., (1978). Pupils and paradigms: a review of literature related to concept development in adolescent science students. *Studies in Science Education*, 5, 61-84.
- [15] Collins, A. & Gentner, D. (1987). How people construct mental models. In *Cultural models in language and thought*, D. Holland and N. Quinn (Eds.), Cambridge: Cambridge University Press., 243.
- [16] White, B. Y. & Frederiksen, J. R. (1986). Intelligent tutoring systems based upon qualitative model evolutions, *Proceedings of the Fifth National Conference on Artificial Intelligence*, (Philadelphia, PA).

- [17] Kempton, W. (1987). Two theories of home heat control. In *Cultural models in language and thought*, D. Holland and N. Quinn (Eds.), Cambridge: Cambridge University Press., 222.
- [18] McCloskey, M. & Kargon, R. (1988). The meaning and use of historical models in the study of intuitive physics. In *Ontogeny, phylogeny, and historical development*, S. Strauss (Ed.), Norwood, NJ: Ablex, 49.
- [19] Vosniadou, S. & Brewer, W. (1992). Mental models of the Earth: A study of conceptual change in childhood, *Cognitive Psychology*, 24, 535-585.
- [20] Martin, R., Sexton, C. and Gerlovich, J. (2002) *Teaching Science for all Children: Methods for Constructing Understanding*. Boston: Allyn and Bacon.
- [21] Hanuscin, D. (n.d.) *Misconceptions in Science E328: Elementary Methods*. [Online] <http://www.indiana.edu/~w505a/studwork/deborah/>. [20/7/2005].
- [22] Eggen, P. and Kauchak, D. (2004) *Educational Psychology: Windows, Classrooms*. Upper Saddle River: Pearson Prentice Hall.
- [23] Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education*, 66(2), 211-227. doi:10.1002/sce.3730660207
- [24] Mali, G. B., & Howe, A. (1979). Development of earth and gravity concepts among Nepali children. *Science Education*, 63, 685 – 691.
- [25] Nussbaum, J. (1979). Children’s conceptions of the earth as a cosmic body: A cross age study. *Science Education*, 63, 83 – 93.
- [26] Brewer, W. F. (2008). Naive theories of observational astronomy: Review, analysis, and theoretical implications.
- [27] Panagiotaki, G., Nobes, G., & Potton, A. (2009). Mental models and other misconceptions in children’s understanding of the earth. *Journal of Experimental Child Psychology*, 104(1), 52-67. doi: 10.1016/j.jecp.2008.10.003
- [28] Frede, V., Nobes, G., Frappart, S., Panagiotaki, G., Troadec, B. & Martin, A. (2011). The acquisition of scientific knowledge: The influence of methods of questioning and analysis on the interpretation of children’s conceptions of the earth. *Infant and Child Development*, 20, 432-448.
- [29] Straatemeier, M., Maas, H. L., & Jansen, B. R. (2008). Children’s knowledge of the earth: A new methodological and statistical approach. *Journal of Experimental Child Psychology*, 100(4), 276-296. doi: 10.1016/j.jecp.2008.03.004
- [30] Nobes, G., Martin, A. E., & Panagiotaki, G. (2005). The development of scientific knowledge of the Earth. *British Journal of Developmental Psychology*, 23(1), 47–64. doi: 10.1348/026151004x20649
- [31] Siegal, M., & Surian, L. (2004). Conceptual development and conversational understanding. *Trends in Cognitive Sciences*, 8(12), 534-538. doi: 10.1016/j.tics.2004.10.007
- [32] Blades, M., & Spencer, C. (1994). The development of children’s ability to use spatial representations. In H. W. Reese (Ed.). *Advances in child development and behavior* (Vol. 25, pp. 157–199). San Diego: Academic Press.
- [33] Ingram, N., & Butterworth, G.E. (1989). The young child’s representation of depth in drawing: process and product. *Journal of Experimental Child Psychology*, 47, 356–369.
- [34] Karmiloff-Smith, A. (1992). *Beyond modularity: A developmental perspective on cognitive science*. Cambridge, MA: MIT Press.

- [35] Nobes, G., & Panagiotaki, G. (2007). Adults' representations of the earth: Implications for children's acquisition of scientific concepts. *British Journal of Psychology*, 98, 645–665.
- [36] Panagiotaki, G., Nobes, G., & Banerjee, R. (2006a). Children's representations of the earth: A methodological comparison. *British Journal of Developmental Psychology*, 24, 353–372.
- [37] Panagiotaki, G., Nobes, G., & Banerjee, R. (2006b). Is the world round or flat? Children's understanding of the earth. *European Journal of Developmental Psychology*, 3, 124–141.
- [38] Glynn S. M. (2007). Methods and strategies: the teaching-with-analogies model, *Sci. Child.*, 44(8), 52–55.
- [39] Donaldson, M. (1978). *Children's minds*. London: Fontana.
- [40] Hughes, M., & Grieve, R. (1983). On asking children bizarre questions. In M. Donaldson, R. Grieve, & C. Pratt (Eds.), *Early child development and education* (pp. 104–114). Oxford, UK: Blackwell.
- [41] Siegler, M. (1997). *Knowing children: Experiments in conversation and cognition* (2nd ed.). Hove, UK: Psychology Press.
- [42] Gelman, R. (1979). Preschool thought. *American Psychologist*, 34(10), 900-905. <http://dx.doi.org/10.1037/0003-066X.34.10.900>
- Gunyou, J. (2015). I flipped my classroom: One teacher's quest to remain relevant. *Journal of Public Affairs Education*, 21(1), 13–24.
- [43] Inagaki, K., & Hatano, G. (1993). Young Childrens Understanding of the Mind-Body Distinction. *Child Development*, 64(5), 1534. doi:10.2307/1131551
- [44] Diakidoy, I.-A., Vosniadou, S., & Hawks, J. D. (1997). Conceptual change in astronomy: Models of the earth and of the day/night cycle in American Indian children. *European Journal of Psychology of Education*, 12(2), 159–184. doi: 10.1007/bf03173083
- [45] Siegler, M., Waters, L. J., & Dinwiddy, L. S. (1988). Misleading children: Causal attributions for inconsistency under repeated questioning. *Journal of Experimental Child Psychology*, 45(3), 438-456.
- [46] Panagiotaki, G., Nobes, G., & Potton, A. (2009). Mental models and other misconceptions in children's understanding of the earth. *Journal of Experimental Child Psychology*, 104(1), 52–67. doi: 10.1016/j.jecp.2008.10.003
- [47] Hayes, B. K., Goodhew, A., Heit, E., & Gillian, J. (2003). The role of diverse instruction in conceptual change. *Journal of Experimental Child Psychology*, 86, 253-276.
- [48] Müdürlüğü, I. I. M. E. (n.d.). 2017-2018 Eğitim Öğretim Yılı II. Dönemi İlk Ders Zili ile Başladı. Retrieved from <https://istanbul.meb.gov.tr/www/2017-2018-egitim-ogretim-yili-ii-donemi-ilk-ders-zili-ile-basladi/icerik/1695>.
- [49] Ümraniye Nüfusu - İstanbul. (n.d.). Retrieved from https://www.nufusu.com/ilce/umraniye_istanbul-nufusu
- [50] Sphere. (n.d.). Retrieved from <https://www.dictionary.com/browse/sphere>
- [51] Www.forsnet.com.tr. (n.d.). Retrieved from http://www.tdk.gov.tr/index.php?option=com_gts&kelime=YUVARLAK
- [52] Alexander, R. (2008). Culture, dialogue and learning: notes on an emerging pedagogy. In N. Mercer & S. Hodgkinson (Eds.), *Exploring talk in school: inspired by the work of Douglas Barnes* (pp. 91–114). London: SAGE Publications Ltd.

- [53] Dickinson, D. K., & Porche, M. V. (2011). Relation Between Language Experiences in Preschool Classrooms and Children's Kindergarten and Fourth-Grade Language and Reading Abilities. *Child Development*, 82(3), 870–886. doi: 10.1111/j.1467-8624.2011.01576. x.
- [54] Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking: a sociocultural approach*. Routledge.
- [55] Wells, A. (2009). *Metacognitive therapy for anxiety and depression*. New York, NY, US: Guilford Press.
- [56] Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994a). *Making sense of secondary science: Research into children's ideas*. New York: Routledge.
- [57] Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994b). *Making sense of secondary science: Research into children's ideas*. New York: Routledge.
- [58] The lion king. (2016). Retrieved from <https://www.youtube.com/watch?v=wzhphX1I0KA>
- [59] Gunyou, J. (2015). I Flipped My Classroom: One Teacher's Quest to Remain Relevant. *Journal of Public Affairs Education*, 21(1), 13-24
- [60] Köse, S. (2008). Diagnosing student misconceptions: Using drawings as a research method. *World Applied Sciences Journal*, 3(2), 283–293.
- [61] Ozay, E., & Oztas, H. (2003). Secondary students' interpretations of photosynthesis and plant nutrition. *Journal of Biological Education*, 37(2), 68–70.
- [62] Wong, D. (2001), Perspectives on learning science. *J. Res. Sci. Teach.*, 38: 279-281. doi:10.1002/1098-2736(200103)38:3<279: AID-TEA1005>3.0.CO;2-#
- [63] Abraham, M. R., Grzybowski, E. B., Renner, J. W., & Marek, E. A. (1992). Understandings and misunderstandings of eighth graders of five chemistry concepts found in textbooks. *Journal of Research in Science Teaching*, 29(2), 105-120. doi:10.1002/tea.3660290203
- [64] Osborne, R. J., & Whittrock, M. C. (1983). Learning science: a generative process. *Science Education*, 67(4), 489–508.
- [65] Driver, R. (1983). *The Pupil as Scientist?* Milton Keynes, Open University Press.
- [66] Cakici, Y., & Yavuz, G. (2010). The effect of constructivist science teaching on 4th grade students' understanding of matter. *Asia-Pacific Forum on Science Learning and Teaching*, 11(2), 1–19.
- [67] Abdullah, M. N. S., Nayan, N. A. M., & Hussin, F. M. (2017). A Study on Addressing Students' Misconceptions About Condensation Using the Predict-Discuss-Explain-Observe-Discuss-Explain (PDEODE) Strategy. *Overcoming Students Misconceptions in Science*, 51–69. doi: 10.1007/978-981-10-3437-4_4
- [68] Briggs, D. C. (2008). Synthesizing causal inferences. *Educational Researcher*, 37, 15–22. doi:10.3102/0013189X08314286
- [69] Gurel, K. D., Eryilmaz, A., & McDermott, C. L. (2015). A review and comparison of diagnostic instruments to identify students' misconceptions in science. *Eurasia Journal of Mathematics, Science & Technology Education*, 11(5), 908–1008.
- [70] France, A. (2019). Teachers Using Dialogue to Support Science Learning in the Primary Classroom. *Research in Science Education*. doi: 10.1007/s11165-019-09863-3
- [71] Lipman, M. (2003). *Thinking in education*. Cambridge University Press.
- [72] Wells, G. (2015). Dialogic learning talking our way into understanding. *Education as Social Construction*, 62.

- [73] Dunlop, J. (2000). How Children Observe the Universe. *Publications of the Astronomical Society of Australia*, 17(2), 194–206. doi: 10.1071/as00194
- [74] Samarapungavan, A., Vosniadou, S., & Brewer, W. (1996). Mental models of the earth, sun, and moon: Indian children’s cosmologies. *Cognitive Development*, 11, 491–521.
- [75] Richland, L.E., & Simms, N. (2015). Analogy, higher order thinking and education. *Cognitive Science*, 69(2): 177-192
- [76] Haglund, J., Jeppsson, F., & Andersson, J. (2012). Young children’s analogical reasoning in science domains. *Science Education*, 96(4): 725-756.
- [77] Guerra-Ramos, M. T. (2011). Analogies as tools for meaning making in elementary science education: How do they work in classroom settings? *Eurasia Journal of Mathematics, Science & Technology Education*, 7(1): 29-39.
- [78] Brown, S., & Salter, S. (2010). Analogies in science and science teaching. *Advances in Psychological Education*, 34(1): 167-169, doi: 10.1152/advan.00022.2010.
- [79] Treagust D. F., Duit R., Lindauer I. & Joslin P., (1989). Teachers’ use of analogies in their regular teaching routines. *Research in Science Education*, 19, 291– 299
- [80] Hien, T. (2009). Why is action research suitable for education?. *VNU Journal Of Foreign Studies*, 25(2). Retrieved from <https://js.vnu.edu.vn/FS/article/view/2240>

Questionnaire Protocol with Students and Interview Protocol with Students

Giriş-Bilgilendirme

Sevgili (öğrencinin ismi)

Bu sene başında uyguladığınız Güneş, Dünya ve Ay derslerinde bazı bilgiler öğrenmiştik bu bilgiler ışığında sizin düşüncelerinize yönelik bir araştırma yapıyorum. Bu araştırma için de gönüllü katılımınla birlikte seninle bir görüşme yapmak istiyorum. Bu görüşmeler sayesinde uyguladığınız programın/etkinliklerin daha iyi ve etkili olmasında yardımcı olacaksın.

Bu görüşme süresince söyleyeceklerinin tümü gizli tutulacak ve başka hiçbir yerde kullanılmayacak ve kimseyle de paylaşılmayacaktır.

Bu görüşme esnasında söyleyeceklerin araştırma için kullanılacak herhangi bir değerlendirmeye tabi tutulmayacak.

Araştırmanın raporunda ismin veya kimliğiyle ilgi hiçbir bilgi yer almayacaktır.

Görüşmemizin yaklaşık olarak 10-12 dakika süreceğini tahmin ediyorum.

Soruların doğru veya yanlış cevabı yok. Senin için doğru olan neyse onu söylemeni istiyorum.

Sence de eğer bir sakıncası yoksa görüşmeyi ses kayıt cihazıyla kaydetmek istiyorum.

Bu görüşme araştırmacının araştırmasına yöneliktir. Okuldaki derslerimizle alakalı değildir.

Başlamadan önce belirtmek istediğin bir şey var mı? Bu görüşme ile ilgili sormak istediğin sorular varsa sorabilirsin.

Dünyamızın Şekli Neye Benzemektedir?



Soru 1: Dünyanın şekli nasıldır? Tarif edebilir misin?

Soru 2: Dünyanın şeklinin bu şekilde olduğunu nasıl biliyorsunuz?

Soru 3: Günler boyunca düz bir çizginin üzerinde yürümeye devam ederseniz nereye ulaşırsınız?



Türkiye'den doğuya doğru yürümeye başlayan bir kişi nerede kendini bulabilir?



Soru 4: Dünyanın bir sonu (uç noktası) veya bir kenarı var mıdır?

Soru 5:



İnsanlar burada yaşayabilirler mi?

İnsanlar burada yaşayabilirler mi?

Soru 6: Resim üzerinde gökyüzünün nerede olduğunu çizerek gösterebilir misin?

Soru 7: Güneş, Dünya ve Ay'ın büyüklüklerine göre aşağıda yer alan cisimlerle karşılaştırabilir misin?



Soru 8: Güneş, Dünya ve Ay'ın büyüklüklerini ve birbirlerine göre uzaklıklarını göz önüne bulundurarak bir model çizebilir misiniz?

B

Questionnaire Protocol with Students and Interview Protocol with Students (English Version)

Preface

Dear (student's name)

We learned some information in Sun, Earth and Moon classes that you applied at the beginning of this year and in the light of this information I am doing a research for your thoughts. I would like to interview you with your volunteer participation for this research. These meetings will help you to make your program / activities better and more effective.

All interviewees will be kept confidential during this interview and will not be used anywhere else and will not be shared with anyone.

What you have to say during this interview will not be subject to any evaluation that will be used for research.

The researcher's report will not include any information of your interest or identity.

I estimate that our interview will take approximately 10-12 minutes.

There are no right or wrong answers to the questions. I just want you to tell that what is right for you.

In case you do not mind, I would like to record the interview with the voice recorder.

This interview is for the researcher's research. It's not about our classes at school.

Is there anything you want to mention before you begin? If you have any questions about this interview, you can ask.

What Does Our World Shape Look Like?



Question 1: What is the shape of the world? Can you describe it?

Question 2: How do you know the shape of the world?

Question 3: If you continue to walk on a straight line for days, where do you reach?



A person begins to walk eastward from Turkey find where you are.



Question 4: Does the world have an end and an edge?

Question 5:



Can people live here?

Can people live here?

Question 6: Can you show me where the sky is on the picture?

Question 7: Can you compare the following objects according to the size of the Sun, Earth and Moon?



Question 8: Can you draw a model by considering the magnitudes of Sun, Earth and Moon and their distance to each other?

Permission Letter Granted by Principal to Conduct Study

Dear Principal,

I am writing to you in regard to asking your permission to work with two of my own classrooms on the school and evaluate their answer of questionnaire according to my criteria. I am master student at Yıldız Technical University, and I am under the advisement of Prof. Dr. Bayram ÇOŞTU. I am currently proposing to conduct a qualitative study in which I use forced questionnaire and interview in 5th grade classroom for a case study.

In this paper I will search an answer these questions;

1. How the 5th grade students define the size and shape of the Sun, the Earth and the Moon and their position relatively to each other.
2. What misconception the students have in terms of the size and shape of the Sun, the Earth and the Moon and their position relatively to each other.
3. How the 5th grade students image the size and shape of the Sun, the Earth and the Moon and their position relatively to each other as three-dimensionally.

I would like to share with you my intentions of the study:

1. I will make the forced questionnaire in the two class I will spend the two lesson for each classroom.
2. I will conduct interviews with some of your students who volunteered to participate from the class (4 students in total). Each of the interviews will take approximately 10-12 minutes. The location will be on the campus for the convenience of the students and the time will be arranged after the daily school hours to avoid any disruption to instruction.

3. All names including the school and participants will be kept secret.

We can talk together, and you can ask anything and request anything regarding access to classroom.

Sincerely,

Nesibe Firdevs ÇETİNKAYA

Master Student

Yıldız Technical University

Graduate School of Natural and Applied Sciences

M.A. Programme in Elementary Science Education



Serkan BAYTAN
Öğretim Üyesi