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Revealing Fifth-Grade Students' Understanding of the Universe

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Abstract. Previous research has shown that students at almost all levels have misconceptions about both the shapes and sizes of celestial bodies in space. This study is essential to conduct on the students who take space topic in their schools for the first time This study aims at revealing fifth-grade students' alternative conceptions about the size of the sun, earth, and moon and their relative positions to each other. This study employs action research by using a forced questionnaire and interview were used as the research instruments and involved 78 fifth-grade students as participants. To collect data, all students initially responded to a forced question questionnaire. Then, based on their responses, four students were chosen to be interviewed to clarify their alternative conceptions. The data analysis was carried out using interview and questionnaire data to reveal understanding and alternative conceptions of students' responses. The results found that students had alternative conceptions of the earth's shape in their minds. Moreover, alternative conceptions are commonly found in the sun, earth and moon positions.

Keywords: science education, alternative conceptions, sun, earth, moon

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INTRODUCTION ~ Astronomy is one of the subjects where children meet great difficulties because of the inconsistencies between what is experienced and what is taught (Hannust & Kikas, 2007, 2010). According to Nussbaum & Novak (1976), several science educators had investigated children's knowledge about the earth's shape, which showed that children held various terms about the earth's shape. Nowadays, students know that the earth's shape is round, but when this information is investigated in-depth, the answers are obtained in such a way that there is a double misconception. For example, the earth has an edge from which people can potentially fall off, and people cannot live at the bottom of the world (Vosniadou et al., 2004). In a mental model of the shape of the earth, the data were collected by evaluating the previous studies (Vosniadou & Brewer, 1992). For example, children think that the Earth is flat. This assumption has been around for a long time. In ancient times, people believed that the idea was real since it was hard to observe the spherical shape of the earth's surface. It seems that the earth is flat based on the surface of the observed earth when you set foot on *the* ground. Moreover, its shape resembles a compact disk that is round, but still flat. The children interpreted this information by looking at the picture or visual sources taken from space, and they said that the Earth is round, however when they looked at the ground where they lived, they saw flatness.

Previous studies show that children have a problem understanding that the earth is like a large sphere surrounded by space (Brewer, 2008; Mali & Howe, 1979; Nussbaum, 1979; Nussbaum &

Novak, 1976; Vosniadou & Brewer, 1992). Several studies have revealed that students, even graduates from universities and preservice teachers, usually have a common misconception about the earth shape by believing it has a flat surface. Helping students understand the scientific conception about the shape and size of the sun, the earth, and the moon and their relative positions to each other is considered an important issue for science educators. Hence, this study seeks to implement and investigate the possible instructional effects in helping students to articulate scientific understandings about the shape and size of the sun, earth, and moon and their relative positionsto each other.

Based on this outline, this study aims at revealing fifth-grade students' alternative conceptions about the size of the sun, earth, and moon and their relative positionsto each other. The research problems formulated are as follows.

1. How the fifth-grade students define the size and shape of the sun, the earth, and the moon and their relative positions to each other?
2. What are the fifth-grade students' alternative conceptions in terms of the size and shape of the sun, the earth, and the moon and their relative positions to each other?
3. How the fifth-grade students three-dimensionally image the size and shape of the sun, the earth, and the moon and their relative positions to each other?

THEORETICAL FRAMEWORK

Ancient civilizations had different beliefs about the shape of the earth. In China, during the Shang Dynasty, people visualized the earth shape like a cross in which they lived in the middle of the cross. On the two arms of this cross, they believed that the world of souls existed. In addition, people in ancient Chinese civilization believed that the earth surface was flat, and the sky was held by mountains in four directions (Major, 1993). This belief in the Shang Dynasty that reigned in 1760-1046 is a sign that the people had been trying to understand the world in which they lived. They wanted to make a meaningful explanation by doing observations even though the past technological was still limited. 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.

The earliest sources of humanity believed that the earth was formed many years ago. Aristotle supported the fact that the Earth was sphere-shaped and depended on the inclination of the shadow that the Earth left on the Moon. Aristotle, 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 between the moon and the earth. 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 these findings encourage the researchers to ask more questions about the universe.

Today, almost every human thought from history seeks to understand and comment on the universe regardless of its conclusions. Earth has a big part of this curiosity about the universe since humans are more likely to think from the nearest thing around. The second place belongs to the moon, which is seen at the night. When people raise their heads, they see the sky. The sky is bright in the daytime and dark at night making people imagine to wonder what happens in the sky.

From the beginning of life, people sense the life in earth is somehow related to what they saw in the sky. Sun is the source of life and the moon causes tides etc. They like to assume what is going on in the sky. Sometimes, their assumption is wrong by believing that the earth is flat and the sun revolves around the earth. However, they have kept searching for an answer to those predictions. Those misinterpretations and failures bring us to our today's knowledge accumulation. How interesting that we see the clues proving that the world is round, but we still think we will fall at the edge of the world (Vosniadou & Brewer, 1992). Moreover, there is an assumption that the sun is huge compared to the earth. Still, the students draw the sun as big as the earth (Vosniadou & Brewer, 1992). This is natural since the students live on earth. They think that the earth is large because moving from one place to another takes a lot of time.

From the historical perspective, the space subject is difficult to be imagined so that it leads to some different explanations. The space size is mostly beyond the capacity of someone's imagination, especially for those students who have limited living places. Although the visual image from the internet, television, or documentary provides a tremendous clue about the space, some people still cannot build bridges between what they assume and what they have learned. Therefore, this study aims at revealing the students' understanding of the size of the sun, earth, and moon and their relative positionsto each other.

METHOD

An action research model was utilized in this study. Action research is a strategy embracing research to practice by making a teacher into a researcher (Eilks, 2013, 2014). Taking into account this feature, this model was preferred since the second author of the study is a science teacher and implemented the research to her students in the class.

Study Group

Overall, 78 fifth-grade students answered the open-ended questionnaire, and four students were selected to be interviewed. The students had commonly low and medium socioeconomic levels. The age of the participants was between 10-12 years old.

Procedure and Data Collection Tolls

In the context of the action research model, a forced question questionnaire and interview technique were utilized. The study was implemented in 2019-2020 spring semester about one-month period.

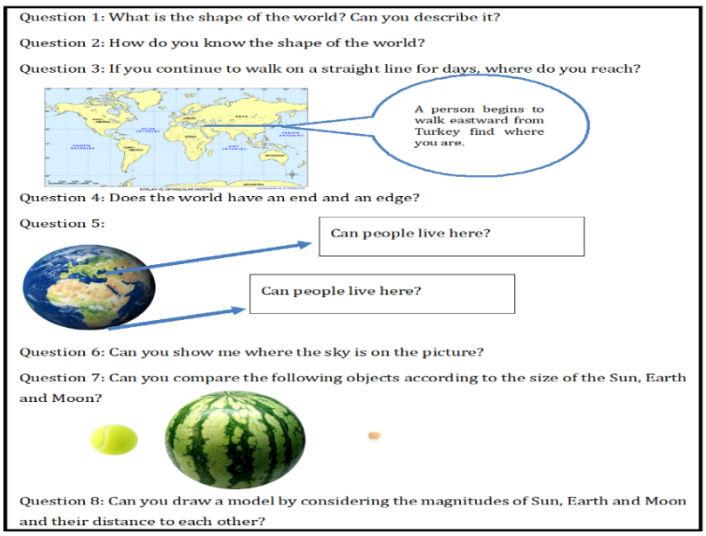


Figure 1. Data collection questionnaire

The forced questionnaire was adapted from Vosniadou et al. (2004) to analyze data on the earth shape. Then, a similar question was added, which was about the relative positions of the sun, earth, and moon to each other. The students were asked to draw a picture related to the shapes of the earth and sun, and moon and their relative positions to each other. Before applying the open-ended questionnaire, the adapted questions were asked to the students to see whether the questions were suitable. At the end of the questionnaire, the students were asked to draw pictures of the earth, sun, and moon together. The interviews were utilized to clarify the students 'alternative conceptions. All these examinations were supported with data from interviews with students that were in accordance with their responses to the questionnaire. Firstly, the questionnaire consisted of eight different questions that were asked to the students (see Figure 1). There were no multiple-choice questions in the questionnaire to reveal students' alternative conceptions. Then among these students, four students who gave different answers to the questionnaire were chosen for the interview.

RESULTS

This section is presented using questions in the questionnaire.

Question 1: What is the shape of the Earth, can you describe it?

With this question, students held ten different main shapes of the earth according to their understanding. As presented in Table 1, most students believed that earth is a sphere, conversely the least numbers of students thought that earth is flat. The number of responses obtained (116 answers) was bigger than participants of (78 students). So, instead of putting them into one label, distribution was done to more than one label. There were common alternative conceptions to the

previous study (Nussbaum & Novak, 1976; Vosniadou et al., 2004; Vosniadou & Brewer, 1992) in this field such that the flat-shaped and disc-shaped earth. However surprisingly, some students said that the shape of the earth is a cube and looks like an egg, and its percentage was not significant. More surprisingly, there was a huge alternative conception about the definition of the sphere.

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

Earth Shapes	Number of answers	Percentage (%)
Sphere	40	35
Round	29	25
Ball	22	19
Circle	12	10
Ellipse	3	2
Oval	3	2
Cube	2	2
Egg-shaped	2	2
Geoid	2	2
Flat	1	1
Sum (N)	**116**	**100**

The question did not reveal the flat-shaped and disc-like earth shape. Most of the students knew the spherical shape of the earth but they could not imagine or connect this information with their real life. They described their world by their observations and believed that earth is flat. Instead of stating it, these students showed their thought in their drawings or emphasized the answer to a forced questionnaire. However, they already showed their thoughts after being asked the earth shape. It is revealed that instead of answering scientific clues, such as photographs from space, the students tended to believe their observation, so the teacher should emphasize daily life examples in their course instead of scientific proof that was not mean anything to the students. These were some of the pictures (Figure 2) showing Earth shape drawn by the students.

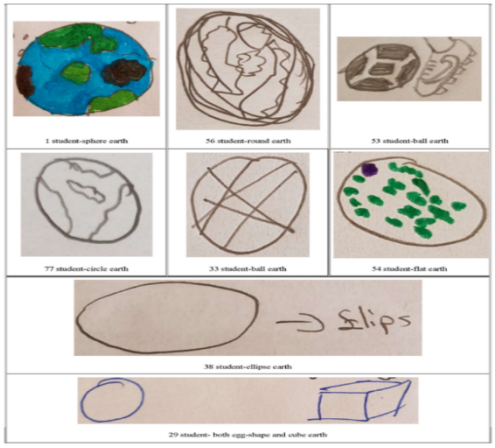


Figure 2. Students answers for question 1

These were the more interesting answers to the first question, such as a student who thought that the earth has both cube and egg shapes. Student 29 should be in a very confusing situation, since he knew that the earth shape is three-dimensional but remains flat like a cube. It was hard to

understand the relationship between egg and cube, but this thought might came from his daily life experiences.

The earth shape was defined as geoid, which should not be given to them. However, the teacher should have mentioned it, and to be able to make more sense, this shape was likened to the egg. Even, if we were linked to the egg, we would have been showing said down egg instead of standing down the egg. Because of this different answer, this student was interviewed to examine the alternative conceptions in-depth. In specific, the utilization of analogies has been extremely successful in inciting understudies to assemble understandings either through hands-on associations with substantial assets (Richland & Simms, 2015) or by making reasonable connections with recognizable items, situations, or occasions (Haglund et al., 2012). Guerra-Ramos (2011) has depicted numerous points of interest and impediments related to utilizing analogy 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, be that as it may, keeps on being a worry. . Notwithstanding the archived low recurrence with which science educators use analogies in their ordinary instructing, based on Treagust et al. (1989) and later in an investigation of Glynn (2007), science instructors were seen to utilizing analogies frequently in their classroom instruction and they had utilized the analogies properly.

> ***Teacher [T]****: 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 an egg shape. What else can you tell? A little sharp at the top like in an egg?*
> ***Student [S29]:*** *The tip is a bit sharp.*
> ***[T]:*** *Is the upper side sharp?*
> ***[S29]:*** *Yes. The lower side is a little sharper than the upper side.*
> ***[T]:*** *You write a cube on the answer. What kind of shape is the cube?*
> ***[S29]:*** *As follows. (*pointing to the shape that she drew*)*
> ***[T]:*** *... Sphere. Look, this cube. Is that like a ball you mean?*
> ***[S29]:*** *Yes.*
> ***[T]:*** *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?*
> ***[S29]:*** *I saw it on the maps.*
> ***[T]:*** *On maps. But for example, this is a map, but I cannot solve the round.*
> ***[S29]:*** *My teacher is saying this in many places.*

As presented in the above excerpt dialogue with Student 29, the instruction was guided and oriented the student since he was not enthusiastic to talk, so the teacher had to give instruction several times. Student 29 had been chosen on purpose since two students answered that the shape of the earth was an egg. It was slightly different from other answers. However, the student meant sphere shape by saying egg in accordance with the interview. In addition, when a few students tried to answer the second question, the same problems were encountered in which he was not able to give a satisfying answer to the explanations. They were forced to give their explanations for the question but his reasoning was not sufficient. Thus, he simply answered it or point on the map.

[T]: *The shape of the earth is a slight trapezoid shape of the round shape. So that's ellipsis. What do you mean by that? You drew it there somehow.*
[S38]: *Yes, it is about the shape of this world that is a bit crooked, but it's like a circle. This shape is called an ellipse.*
[T]: *Like an ellipse? Or like a ball?*
[S38]: *Like a ball. But for example, there are different balls. Such trapezoid balls…*
[T]: *Did you compare it to American football?*
[S38]: *Yes*
[T]: *Do you think of another name as an example?*
[S38]: *It's not coming.*

In the above interview excerpt, Student 38 defined the trapezoid as an ellipsis. There is an alternative conception with the definition of some terms. This was an unexpected concept. Although the guided questions seemed worse, it was more effective to remove the alternative conceptions. The most distinctive drawing is that Student 5 drew two sets of circles collapsed into each other as in math. The comment was not significant since they were fifth-grade students who could not be aware of some of their actions. These three words (ellipse, trapezoid balls, circle) mean nearly the same as each other. It should have been examined if there were any differences between them when the students answered them. We should look at the definition of these words and examine any cultural differences. A sphere meant a solid geometric generated by the revolution of a semicircle about its diameter; a round body whose surface was at all points equidistant to the center. When we looked at the definition of the round, we encountered that having a flat, circular surface, like a disk. In English definition, there was a difference between round and sphere, but some of the definitions were still the same for them. The round had a meaning of surface, which aroused alternative conception for us. However, when looking at the definition in our culture, they can be used for another. Round means ball or sphere. More importantly, the round and ball shapes have nearly the same definitions. Some of the students could think whether the sphere and the round were the same or not. In the interview with Student 1, there was an example of another meaning of the sphere according to the students.

[T]: *Now you call it the sphere of the earth. What do you mean by sphere?*
[S1]: *My sphere is meant by my teacher, for example, the sphere is blue and green. For example, blues show the sea. The greens show green things on the land and the brown plains.*
[T]: *And how do you know that's the way it is?*
[S1]: *I think scientists have explored the way this is. They share them with pictures on the internet.*
[T]: *So, you know from the pictures? Is there anything else that you have been told that you can hear?*
[S1]: *No*

As seen in the above excerpt, the shape of the earth was clearly understood by Student 1 but they had trouble with it when they gave justification, which was not a coincidence. The type of instruction made in public or private schools had a teacher-based structure. So, the students had a hard time giving an example for their claim. They only knew the facts; they did not interrogate what they knew. They were not aware that the scientists had even more than one idea on a

particular subject. They thought that there was only one truth, which must been justified by some authorities. In other words, they memorized the facts, so it was so hard to find their misconception. Maybe they could not reveal the 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 did not change the results of what they knew, but firms answer could be gained.

In the research, there were 13 students who wrote earth is sphere-shaped also wrote that earth is ball-shaped. Besides, nine other students wrote that the earth is ball-shaped. It seems that the ball-shaped ones were more related to each other in a spherical shape. Moreover, the research showed that the number of students who wrote round and ball together was nearly the same in number compared to those who wrote sphere and ball together. Sphere, round, and ball probably have equal meaning in the students' minds. Following is Student 53 who answered that earth is ball-shaped.

> ***[T]:*** *How do you compare it to a ball? (Your drawing of the earth) Like an American football? Like a regular ball? Or like a basketball ball?*
> ***[S53]:*** *Yes, like a normal ball.*
> ***[T]:*** *So how do you know the shape of the world is like this?*
> ***[S53]:*** *I have heard such things in my life before.*
> ***[T]:*** *What did you hear?*
> ***[S53]:*** *I heard about it at school. In primary school or something. I do not know if it was a class 4. They were told in the social studies class about the world'*
> ***[T]:*** *What is left of those lessons?*

As seen in the above excerpt, Student 53 was sure about her belief that earth is ball-shaped and insisted to claim that her answer was correct. At a particular moment, she hesitated to give an example, but this could be an anxiety that she had. The instructor asked follow-up questions to confuse the student's mind, however, she still gave the right answer that she believed. The steady answers made us believe she did not have a misconception at all by comparing the answer to the second and third questions and so on.

Question 2: How do you know that the shape of the world is like this?

This question was highly related to the first question. Some of the students' answers were the same and mixed with one another. Even if some of the students answered that earth is sphere-shaped, they still believed that earth is flat. There are also examples in the answer given by students in the second question.

Table 2. The distribution and rubric of the answer of the students to question 2

	Answer that has been classified			f	%
Scientific source	science magazines, newspapers, and any published material	internet, websites, etc.	scientists or experts	35	41
From teacher	I heard in the lesson	our teacher said this in the classroom	we studied the shape of the earth is ...	17	20
Picture of earth	picture in science magazines, newspapers, and any published material	the picture on the internet, websites, etc.	picture in a course book	21	24
Giving proof and explanations	any kind of daily life experiences	the explanation that had been talked about in the classroom	example in the course book	7	8
Unable to classification	empty answer	drawing shape of the earth or anything instead of giving an explanation	writing about different topic	6	7

In Table 2, there is an answer classification to the second question developed based on the students' answers. A main alternative conception to the second question was made that earth is round.. There is an interesting situation in which most students (41%) answered that they knew it from scientific resources, even if they learned from their classes, since they knew that scientific evidence needed to be correct. Thus, they were not clarifying their answer with an example. This should be a reason for teacher-based learning style. The students who were used to teacher-based learning style tended to believe that teacher who was an expert should know much better them. Hence, they justified their answers with expert thought and comments such as scientific. Moreover, only seven students gave scientific evidence that had been learned in the school. However, this was a not bad thing since it meant that the students adopted this understanding from their previous learning. It showed the acceptance of the examples that they had been given in the class.

[T]: *You said that the shape of the world is like this. At sea, the 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?*
[S59]: *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.*
[T]: *How can he notice?*
[S59]: *For example, a round shape is created by walking. Like when you swim.*
[T]: *I do not understand much. What do you mean by the horizon?*
[S59]: *You know, there is a line like that at the end of the sea. I'm talking about that line.*
[T]: *And if he swims to that line, does he reach it?*
[S59]: *Well, maybe he can't, maybe he can't.*
[T]: *What if he does? What will he see when he gets there?*
[S59]: *I have no idea.*
[T]: *What if he doesn't get it? Will he continue to swim?*
[S59]: *If he does not reach, he continues to swim. He will not swim if he meets him.*

[T]: *You said scientists researched. The shape of the world is round… Do they investigate this skyline again?*
[S59]: *Yes. They taught it in elementary school by teachers. If I remember correctly.*
[T]: *What did they say?*
[S59]: *Here they talked about the horizon. They said the world was round.*

As a first reaction, the student answered, "*I read it somewhere*". Then, this answer was changed into "*They taught it in elementary school by teachers*". Student tended to expect all the knowledge from their teacher as a piece of scientific information. Moreover, the teacher asked many leading questions making student confused a little more. Although these directions seemed to be challenging, some studies had stated that asking too many questions was a positive attitude toward students' learning. A classroom with an efficient dialog was capable of creating a wealthy and profound understanding of ideas, promoting and expanding higher order thinking among learners, and encouraging communication skills (Alexander, 2008; Dickinson & Porche, 2011; Mercer & Littleton, 2007; Wells, 2011). Mercer & Littleton (2007) suggested that teachers used four strategies to improve student talk quality. Responding to students' responses and using more open questions encouraged the students to talk a bit more on the topic.

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

This question served the same reason with the previous two questions, which was to provoke the alternative conception deeper. More importantly, it was a forced question, since it led the students to think about how the result should be. There was also a big world picture having two dimensions that facilitate students' abstract thinking. Two dimensions of the world pictures (see Figure 1) were selected for increasing the misconception in the students. The students were not familiar with this type of question.

[T]: *Let us pass the next question. Now I have walked for days, starting at some point. Then I come back to where I was. Why is that?*
[S50]: *Because the world is round so that it looks like a sphere and wandering around again*
[T]: *You said you'd come to the same place. But do we say the world has an end? You said you didn't.*
[S50]: *I do not think so.*
[T]: *What is the reason?*
[S50]: *Because the round has no edge, no corner.*

From the above excerpt, it is seen that the student did not have any alternative conception about the earth shape, since she said the round had no edge and corner. This answer made it easier for the students to understand the answer that the earth had an egg shape. There was only one student who responded that the shape of the earth was flat. In the first question, he said earth was a sphere, however, in this question, he changed his answer into flat earth. According to another example, the student interfered with the answer by looking at his previous daily life experiences. He said that when someone went further through the earth, he would end up on the horizon.

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

	Number of the answers	Percentage (%)
Sphere	65	83
Flat	2	3
Unable to classification	11	14
Sum (N)	78	100

Horizon refers to flat shape of earth because there was an end that could not be reached. It was a kind of endless linear distance that earth had. This child had trouble with the imagination of seeing the earth as a sphere. Probably his daily life experience said so. Another student [S42] who gave a different answer said that she would go and then end up in South Korea, since she believed that it is the farthest place on earth. By believing this, it means that this particular student thought the earth is flat, which shows a misconception. Although this answer was found irrelevant, however, her answers to the first and fourth questions showed that she did not have a misconception about the earth shape.

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

This question focused on the sizes of the sun, earth, and moon. Most answers said earth is a sphere, while in contrast, a smaller number of students said that earth is flat. The following table presents these answers and their alternative conceptions. One of the most common misconceptions is that horizon is the end of the world, so they say that there is a horizon at the end instead of a cliff.

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

	Number of the answers	Percentage (%)
No, there is no end	61	78
Yes, there are end	13	17
Unable to classification	4	5
Sum (N)	78	100

In this question, students thought that everything had an end on the earth as well as an end. Therefore, they often seemed to have made more misconceptions, since they previously stated that the earth is sphere , but then believed that the earth is flat like a CD..

Question 5: Can people live here? (pointing out the part of the world, see Figure 1)

Based on these findings, it is interesting to investigate how the students combine their daily knowledge of gravity with their concept of the shape of the earth. There were only five students who gave the flat surface earth answers among the students who understood the question in wanted. So, it was hard to explain the alternative conception of the students. It was not understood that people did not stand upside down in the lower part of the world due to gravity. Most of the students wrote that in the upper part of the earth there was land, so people could live there. On the contrary, in the lower part of the earth shown with an arrow, there was no land and so there would be no sign of life. However, on the lower side of the earth pointed with an arrow

still had a land. The 5th question was one of the foremost troublesome addresses to get it. Most of the students got this address such as whether they were appropriate for the human being or not.

> ***[T]:*** *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.*
> ***[S38]:*** *Yes. Because many places in the world are reliable. That's why.*
> ***[T]:*** *Then you looked at whether you lived somewhere in terms of reliability.*
> ***[S38]:*** *Yes.*
> ***[T]:*** *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?*
> ***[S38]:*** *I think he can't. Because it could be somewhere in the sea.*
> ***[T]:*** *No, not the sea. Black. But this guy is down in the world.*
> ***[S38]:*** *Viable.*

As seen in the above excerpt, Student 38 realized the shape of the world as a sphere. In the beginning, the teacher asked the question of the student's answer to be able to get a more accurate decision before judging, since there was a problem at the beginning the question was not clear for the students because of the lack of gravity concepts. Some of the students wrote that question upper part was so hot to live or so cold to live. This also showed that the students did not know how the climate of the southern part of the earth. They were unfamiliar with that part of the world. By looking at the picture, they were mostly guessing. One of the strange answers that mentioned the upper side of the world, people could live here, since there was industry. There should be one explanation for this. The arrow showed the European part of the world, in contrast, the lower side of the world which has been pointed with an arrow is an unknown place to the students. There was also one answer that this was a forest area since it seemed green. In other words, the map of the students was adequate for this question. As in the previous data, the student was comfortable knowing the shape of the earth, however, the gravity concept was new for them. In the curriculum, gravity was not covered in 5th grade, so it was normal for to students who were not able to answer. Also, they were not. The following is the teacher's guidance that leads to misconceptions.

> ***[T]:*** *What we have done here. If you keep walking in a straight line for days … It's liked your swim on the horizon, isn't it?*
> ***[S15]:*** *Yes.*
> ***[T]:*** *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?*
> ***[S15]:*** *Yes. I think it's like that.*
> ***[T]:*** *You said that there is a horizon at the end of the world.*
> ***[S15]:*** *Yes. When I say the edge, I gave the skyline as an example.*
> ***[T]:*** *Then can we say to the end of the world: There is a sea. At the end of this sea, there is a skyline.*
> ***[S15]:*** *Yes*
> ***[T]:*** *But what happens after you cross here?*
> ***[S15]:*** *For example, I think it's like turning upside down.*
> ***[T]:*** *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?*
> ***[S15]:*** *Could be. Maybe he can turn around. It either falls or reverses.*
> ***[T]:*** *What is it like to turn upside down? Are your feet in the air?*
> ***[S15]:*** *May I swear. But I think it falls with a great chance.*

According to his previous answers, he had a globe-shaped world perception. Now, the student thought that he was going towards the end of the world when, or he would turn upside down as if he were turning a book page. At least he thought it would reverse, considering the presence of gravitational force.

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

The main aim of this question was to reveal if the students had an alternative conception about the shape of the earth one more time.

Table 5 The distribution and interpretation of the answer of the students to question 6

	Interpretation	Interpretation	Interpretation	f	%
Cloud	a common idea is a flat earth.	a common idea is the sphere of earth.	evaluated this answer with the help of looking at other questions' answers and other things in the drawing	39	38
Spaces/ Satellite	a common idea is the sphere of earth.	a perspective from the space instead of the ground can mean a sphere of earth		30	29
Only top	common idea is flat earth.	can be habit drawing sky as in the top of the earth		31	30
Day/ Night	can mean the sphere of the earth if the student thinks day and night can follow each other by turning the earth around itself	still can mean the flat earth		1	1
Unable to classification	drawing earth shape instead of drawing sky	drawing something else different from the sky	writing answers or filling empty	2	2

Drawing the sky was one of the challenging questions related to the shape of the earth. When students were asked to draw the sky, most of them visualized it based on their imagination and drew what they saw. However, if the students did not have a misconception about the shape of the earth, they should draw the sky in 3D. There should be a sky at the top of the paper that the student drew on as well, they should draw the sky at the bottom of the paper. At the point when the students came to fifth grade, they knew the state of the earth was comparable with round, yet they did not learn the earth with a geoid shape. From that point, the students should know that the earth had a geoid shape and should include a sky that was not only at the top, but it should be all over the place. Table 5 presents that there were 39 students who drew clouds on their paper. However, there was only one student who drew the day and night. Day and night come to one after another, so it recalled the roundness that as a conclusion drawing day and night should be placed in the sphere earth concept.

Figure 3. Example of irrelevant drawing (Student 56[t]) **Figure 4.** Cloud and satellite

In Figure 3, the student might have drawn the sky as seen in the picture of the earth. However, it should have been classified as irrelevant, since there was no difference between the picture of the earth and the sky. On top means that, the student drew only the sky at the top of the paper instead of the round sky. Spaces and satellites meant that the student drew the sky as a perspective from the space instead of the ground. That is to say, the world for the place where he stood, and the atmosphere becomes extra-terrestrial space for him. In this question, most of the students drew the sky as one dimension like in flat surface. There were 31 students who drew the flat surface of the earth. Most of the students drew their clouds at the top of the picture. The student decided to choose a perspective that is from space. There were also the sun, earth, and moon in one picture, so it gets disclosed from the purpose of the question. Clearly, the student drew the sky under the effect of the other questions. The most interesting part was that the student imagined the sky as a space but at the same time he/she thought that there should be a cloud in one part of the sky. He/she could draw the sky and above so that, he/she drew this picture as the earth had a flat surface, since the ground he/she lived in at the very bottom of the picture then he/she drew the clouds after that he/she drew sun, earth, and moon in the upper part of the picture.

[T]: *Now you've drawn the sky here. What's in the sky? What are those?*
[S38]: *Cloud, moon, and star.*
[T]: *So, where are we?*
[S38]: *We are not here.*
[T]: *Why?*
[S38]: *We don't have because I drew the air here.*
[T]: *Hmm. You say up in the air. So, where's it up?*
[S38]: *Up the hill. To the top.*
[T]: *Is one on top?*
[S38]: *No.*
[T]: *Where else?*
[S38]: *Could be on the side. So, it can change.*

Student 38 drew a star and some space objects such as the moon and clouds. The concept of the sky was understood well. However, the concept of the sky was all around us at the up and the bottom is not fully covered. As in the previous discussion that Hannust & Kikas (2007) held the students actually think that the earth has a shape of flat and sphere such as a CD shape. In Figure 4, there is a satellite, stars, clouds, and a sun. There is a big thing, which looks like the shape of a house or church. The student wrote satellite nearby this shape. We can say that the student has a logic that the earth has a sphere shape, the sky and space are drawn in diagonal position rather than at the top of the picture, it is a different topic, but the student understandably does not know what the cloud is or not.

Question 7: *Can you compare the following objects (see Figure 1) according to the size of the Sun, Earth and Moon?*

In this question, it was asked the students to match the size of the sun, earth, and moon to the familiar object that they already know (tennis ball, watermelon, and chickpea). It is an easy question in terms of both answering and comprehending. The following is an example:

> ***[T]:*** *What did you say to the world? Is this big?*
> ***[S45]:*** *No.*
> ***[T]:*** *How is the sun?*
> ***[S45]:*** *He is also great. It's pretty big. But I drew it as big as it was.*
> ***[T]:*** *What do you mean?*
> ***[S45]:*** *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.*
> ***[T]:*** *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.*

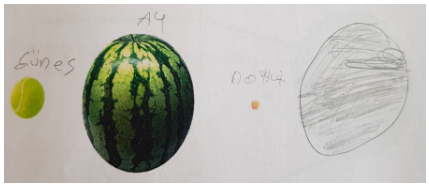
The answer given by the student about the size of the sun, earth, and moon was highly satisfactory. "So, this is now very big in the sun. It's pretty big. The teacher showed him that much in the picture, but bigger than him." By saying this the student shows how sure his/her answer is with it. He/she emphasizes 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 seem adequate, since the sun drew bigger than the earth and the earth drew bigger than the moon. To be correct, there should be significant differences, which are hard to show. The moon should be smaller than the dot when we compare the sun which can be drawn as the size of a watermelon. Again, the important thing the students need to understand is that the size of the sun is bigger than the earth and the moon. Also, the size of the earth is bigger than the size of the moon. Mostly, they use a similar example with this question.

Table 6. The distribution of the answer of the students to question 7

	Number of the answers	**Percentage (%)**
Accurate in size	61	79
Inaccurate in size	7	9
Unable to classification	10	12
Sum (N)	78	100,00

As presented in Table 6, 61 students answered watermelon specifying sun, tennis ball specifying earth, and moon specifying chickpea. Some students do not answer this question. They leave the question empty. There is also one student who gives only an explanation but does not draw or match with the picture. In this question, it might be wise to differentiate the answer into two groups. The first group was the one who did mistakes in finding earth and moon size correctly. Since four students were confused about the earth being bigger in size than the moon. The second group was the one who misinterpreted the size of the sun incorrectly. The sun has the biggest size among them all for who understands the size of the sun, earth, and moon. In group one who did mistakes in finding the earth and moon size correctly, there was one student who wrote a correct explanation and draw in the eighth question might not have a misconception in this part. The student wrote moon on the top of the tennis ball and wrote earth on the top of the watermelon,

but he did not write anything on the top of the chickpea. She may have missed the sun or cannot see the chickpea as well. We can clearly see that the sun has the biggest size among them and the earth follows. Moon has a smaller size than the earth. There is a contradiction between the students' drawings. This confusion may not indicate the misconception. This one should be a minor error. There was also one student who forget the earth. He wrote sun for tennis ball and moon for watermelon, but there was no sign of the earth. In Figure 5, the students (Student 44) drew that the size of the sun and moon was enormously wrong. This picture clearly indicates that the student did not have a logic of the size of the sun and moon when comparing them to each other. In Figure 6, the student (Student 13) wrote earth which is a living place to her and there could be a reason for this misconception of watermelon.



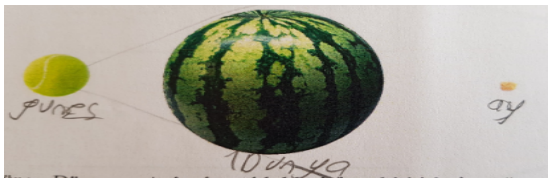


Figure 5. Student 44's drawing Figure **6.** Student 13's drawing

She saw that the tennis ball should be for the sun and the chickpea is for the moon. Only the size of the moon was correct, however, the size of the sun was made smaller than it should be. She probably defined the world based on her judgment, so the living place home should be bigger than any other space subject.

Question 8: Can you draw a model by considering the magnitudes of sun, earth and moon and their distance to each other?

This question is to reveal the misconception of the 5th-grade students.

Table 7 The distribution of the answer of the students to question 8 part 1

Sun	Earth	Moon
67	62	63

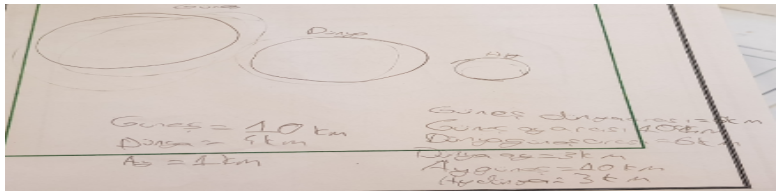
Table 8. The distribution of the answer of the students to question 8 part 2

Sun and earth	Sun and moon	Earth and moon
42	44	17

Incredibly there were too many misconceptions in this question to the other questions. Although the seventh question was about the size of the sun, earth, and moon, the eighth question is remark more misconceptions than the seventh question in terms of the size of the sun, earth, and moon. The most challenging part for students should be the distance between the earth and the moon. When we considered all the three objects (sun, earth, and moon), the students could understand

that the distance between the sun and earth was large, however, when we put the moon into the equation the students missed the fact that the distances between sun and earth were larger than the distance between the earth and moon, so most of the time they drew same distance between earth and sun and earth and moon together. Some of the students gave the approximate distance between these three objects in their drawings. Even if they know the exact distance they draw the earth closer than it should be. We put these answers into the irrelevant. There was also a drawing that did not contain orbits, we also put these drawings into the irrelevant. Some of the students made equal distances between the sun, earth, and moon. The seventh and eight questions were asked to give information about the size of the sun, earth, and moon to check the previous answer of the students. Seven students did wrong the size of the sun, twelve students did wrong the size of the earth, and eleven students did wrong the size of the moon. This finding is parallel to the answer to the seventh question since the size of the sun is understood more than the earth and moon itself. Also, the students seemed more uncareful when they drew the size of the moon and earth. Even if the students can understand the subject that the distances between sun and earth are larger when we consider all three sun, earth, and moon. Students missed the point that the distance between the moon and earth is shorter than the distance between the sun.

Figure Error! No text of specified style in document.**7.** Student 61's drawing. **Figure 8.** Drawing



showing student did not know the exact distance

In Figure 7, the Student 61 wrote watermelon under the sun which is the left side of the picture. In the middle, there is an earth and a written soccer ball at the bottom. On the right side of the picture, there is a moon which is written ping-pong ball. The size of the space object is relatively true, however, the student missed the point that the moon and earth should be far away from the sun. There were also the students who gave the digital number of the distances between the sun, earth, and moon, but they drew the equal distances between the sun, earth, and moon. There could be two reasons. One of them could be they made failure to an evaluation of their knowledge. In addition to that, they cannot care about their distance when they draw the sun, earth, and moon. Figure 8 is for a second reason. In this, the student did not know the exact distance between the object but he gave the number according to himself. 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 the moon is a little bit closer than earth sometimes. He wrote earth is four kilometers far away from the sun and the moon is one kilometer far away from earth. So, he made the point that the sun is far from the moon than the earth and the earth is near to the moon. The other students can only use a small amount of space in the

questionnaire paper, which can lead to the closeness between the sun, earth, and moon. Drawing is so incapable of showing the thought of the students. Such as this interview the student himself says that there is a distance between them. Since there are two more planets between the sun and earth which is a cause of distances. Moreover, there is an interesting point that the student could not give an example of the distances between earth and the moon which is understandable none one on the earth are not able to see or define such a distance in real life. In this question, we did not know that the student talked about the distance between the sun and other planets by thinking of the position of the sun in the whole universe because the student seemed to believe that the sun and planets are near to each other, there are more spaces bodies in the universe. However, we should also consider that the students still have been making mistakes in terms of distance between the objects.

DISCUSSION

Learning about stars can be done unintentionally when a child starts to build knowledge about a phenomenon while experiencing it in real life (Driver et al., 2014). This process begins before the students start formal education. This process can begin when the baby is still in the womb, since this process is unstoppable. Children like to learn something new and like to link their previous learning with the new experience If the children make this connection unscientific, there might be some misconception about what they learned. The teacher lectures on the new subject, and the students make this new concept to the old one. However, the teacher has a big responsibility for shaping the misconceptions. Misconceptions that are developed unintentionally before formal school education have often been supported by inadequate the way of teaching used in the classroom (Wong et al., 2001). There is also another factor that is not considered in this research. Some studies say that knowledge provided in the textbooks (Abraham et al., 1992), the use of everyday language or metaphors and analogy (Osborne & Wittrock, 1983), and the experiences that students face in their daily lives (Driver, 1983; Driver et al., 2014) are common effects that misguide students into misconceptions.

In this research, the main concern is to reveal students' alternative conceptions about the size of the sun, earth, and moon and their relative positions to each other. The study result showed that considerable amount of the students held a few misconceptions in their mind. Conversely, the data also showed that the shape of the earth was almost understandable for them. They could imagine the earth as a sphere object. It was observed that the students had a difficult time answering such an open-ended question, which needed long answer and justification. Most students defined universe based on their observation believing that earth is flat. They demonstrated their thoughts in drawing and emphasized in the forced-questionnaire response. It is so crucial that the students tended to observe them instead of observing the academic clues, such as photography from space, so the teacher should emphasize on the daily teaching materials rather than scientific evidence that is meaningless to the learners.

In Turkish education system, the students are taught to find answers among the choice, not just in the multiple-choice questions, but in the lecture itself. They have a hard time providing evidence for what they learn. As a proof of this claim that in the first question the two of the students answered the shape of the earth is like an egg since their teacher told them that "*imagine an egg which is tilted that what the earth looks like*". They gave this answer to the first question after that they answered the second question (which is how you know the shape of the earth like that) that "*I know because a scientist says that*". This should be due to the learning style of the teacher. Students who are get used to traditional are more tempted to think experienced 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 magazines or websites. Another example is when the teacher begins with the question that what part of the ship that can be seen 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. However, the earth is round, the ship's mast will be seen first and then the body and the rest of it. Moreover, it has been observed that photography has been taken from space is clear evidence that the earth has a sphere shape. This evidence was mostly written by students in second questions. Cakici & Yavuz (2010) 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 enhancement in achievement among the experimental group students in contrast to the comparison group. In particular, the teaching-based constructivist approach appears to be effective in eliminating misconceptions. Another study showed that students who learned about the phases of the moon using the inquiry-discovery approach have a better comprehension of the topic than the comparison group students (Abdullah et al., 2017). 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 (Briggs, 2008). There is also another point that the students have to be faced with a problem the definition of some words is confusing. The reason behind that the definition of the sphere or round and circle was not well-understood by the students, which made it hard to distinguish where the real misconception is.

To reveal the aforementioned students' alternative conceptions, the interview was a good choice compared to the forced questions questionnaire. Gurel et al. (2015) investigated all 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 (two and three tiers). To sum up, interview is a good technique that reveals the misconception at a more appropriate level. Also, it gives more opportunities to ask more than one question to the students and change your next question according to the students' answers. Teachers can

make more understandable the answer by asking the question more than once to the students to get satisfaction with the answer. Moreover, France (2021) stated that teachers working to promote efficient dialog are also needed to have high-level questioning abilities. High-level questioning abilities might provide to reveal alternative conceptions in a 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 (Lipman, 2003). Dialog was shown to create students' reasoning when used efficiently, leading to greater order thinking and academic gains (Mercer & Littleton, 2007; Wells, 2015). There is a question that arose whether the teacher asks more questions badly affects the effectiveness of the interviews or is the opposite. There is some academic research that advocates the usage of asking questions effectively to develop the student's learning. A classroom with efficient dialog is capable of creating a wealthy and profound understanding of ideas, supporting and expanding the thinking of greater order learners, and promoting communication skills (Alexander, 2008; Dickinson & Porche, 2011; Mercer & Littleton, 2007; Wells, 2011).

CONCLUSION

This study focuses on students' alternative conceptions size and shape of the sun, the earth, and the moon and their relative positions to each other. The findings revealed some alternative conceptions of the 5th-grade students held in their minds. One of the reasons for students' alternative conceptions may stem from the inability to make adequate concretizing observations about space. Hence, teachers should use techniques such as video, real observation, and simulations to make more concrete the universe concepts for their students. Also, the science teachers and researchers should consider the students' alternative conceptions presented here to teach or organize the research about universe concepts.

The findings indicated that the interview was a good technique, revealing the misconception at a more appropriate level compared to the forced questions questionnaire as discussed in the literature (e.g. White & Gunstone, 2014; Gurel et al., 2015). Therefore, the interview technique should be preferred to reveal students' alternative conceptions.

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