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How do gifted elementary students perceive Earth's shape and gravity?

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ABSTRACT

The purpose of the study was to determine the perceptions, knowledge levels, and mental models of gifted 2nd and 3rd-grade elementary students regarding the shape of the Earth and gravity concepts. The data for the study, which was qualitative research, was collected through interviews with the students. The study participants were 80 students taught in a Science and Arts Center (SAC) affiliated with the Ministry of National Education in the Mediterranean region. According to the research results, it was found that 3rd-grade students have four different mental models, while 2nd-grade students have five different mental models. It was found that students had difficulty in establishing a relationship between their ideas about the shape of the earth they live in and what they have learned and that their knowledge obtained from different sources was contradictory. The results of the study were compared with research findings in the relevant literature and it was found that gifted students had more scientific mental models than students in the same age group who were not classified as gifted.

Keywords: astronomy, Earth's shape, gifted students, gravity, mental model

INTRODUCTION

Astronomy is one of the oldest known sciences. The development of technology has increased people's interest and curiosity in astronomy. Astronomy education, offered through various instruction in schools, museums, or observatories, has gained considerable importance today. One of the goals of science education is to provide students with basic information about astronomy. To this end, basic information about astronomy is included in the science curriculum at each grade level as part of learning about the Earth and the universe. Astronomy topics are taught as courses in many countries because they improve students' scientific thinking skills and increase their interest in math and science courses. (Tunca, 2002). In the literature, some studies (Baxter, 1989; Bryce & Blown, 2006; Ozsoy, 2012) have investigated the astronomy concepts of students at different levels of elementary education. In addition to their schooling, children learn astronomy from two sources: their observations in daily life and communication with people (Hannust & Kikas, 2007; Vosniadou & Brewer, 1990). Most of this information that students receive throughout their lives is far from scientific fact and creates misconceptions (Sewell, 2002).

As fundamental concepts of astronomy, the concepts of the shape of the Earth and gravity are areas of research interest to investigators. For children to develop a scientific understanding of the shape of the Earth, the properties of apartment and round must be considered together and achieve synthesis in this context. This situation leads to difficulties in achieving scientific understanding that requires children who walk on apartment ground and have an apartment understanding of the Earth based on their observations to abandon that understanding and think about both the properties of roundness and flatness together (Sadler, 1992; Vosniadou & Brewer, 1990, 1992). To teach these concepts effectively, pedagogical activities related to these concepts should begin in elementary school and continue in the following years (European Association for Astronomy Education [EAAE], 1994). When examining instructional programs in formal education in our country, students encounter content on the shape of the Earth in the last unit titled "Life in Nature" in the 2nd-grade life science course. In the science curriculum, there are units of instruction on the Earth and the universe at each grade level, while students directly encounter content on the shape and motion of the Earth in 3rd grade and the concept of gravity in 7th grade.

Gifted students are characterized by high levels of perceptual ability, advanced learning, higher levels of awareness and creativity, high levels of attention and motivation to topics that interest them, etc., compared to other students (Akarsu, 2004; Levent, 2014; Sak, 2012). More than one of the gifted students with these characteristics tend to engage in science as their main interest and curiosity from an early age (Van Tassel-Baska & Stambaugh, 2009). Gifted students are thought to have a better understanding of scientific concepts and science education is more meaningful and interesting to them than to their peers (Brown et al., 2006; Joyce & Farenga, 1999). In addition, a review of the literature has revealed that gifted students' focus on science

learning is concept-oriented (Ozarslan, 2015; Van Tassel-Baska & Stambaugh, 2009). One of the topics of interest to gifted students is astronomy (Subasi et al., 2015). A limited number of research studies were found (Onal & Onal, 2021; Subasi et al., 2015); no research was found with gifted students based on the concepts of the shape of the Earth and gravity.

In examining the research studies in the literature based on the concepts of the shape of the Earth and gravity, Hannust and Kikas (2007) conducted a study with five-, six-, and seven-year-olds and examined their knowledge of astronomy and the processes of change in their knowledge throughout the children's school years. They found that children easily acquire factual knowledge, and thus suggested that children should be exposed to basic facts in early education. In another study, Vosnyadou and Brewer (1992) conducted their studies with first, third, and fifth-grade students in which they examined the nature of students' knowledge about the shape of the Earth and how that knowledge changed. They found that students have non-scientific mental models that decrease as grade level increases. A study by Baxter (1989) examined the mental models of students ages 9 and 16 regarding gravity and the shape of the Earth. He identified four different mental models related to the shape of the Earth and gravity, one of which was scientific.

Another study by Ozturk and Doganay (2013) investigated fifth and eighth graders' understanding and mental models of earth shape and gravity concepts. Their results showed that fifth and eighth-graders had different understandings and mental models about the shape of the Earth and gravity, one of which was scientific. In a more recent study, Ozgul et al. (2018) examined the mental models of 60-72-month-old children regarding the shape of the Earth. Their results suggest that children had alternative concepts about the shape of the Earth after synthesizing scientific knowledge and daily observations. A study by Ozsoy (2012) investigated the understanding of first-year students regarding the understanding of the shape of the Earth using the method of drawing. The results of Ozsoy's (2012) study showed that freshmen had difficulties in understanding the round shape of the Earth and had various misconceptions about it, as shown in this study. Sackes and Korkmaz (2015) investigated the conceptual understanding of preschoolers aged 60-72 months regarding the shape of the Earth. Their results show that children have four different mental models, one scientific and three naïve.

A review of the literature revealed that studies investigating the shape of the earth and students' concept of gravity mainly use interviews and drawing techniques as data collection instruments. The use of more than one data collection tool in this study to investigate students' abstract concepts such as earth and gravity is one of the strengths of our study. In examining the research studies in the literature, it was found that the study groups examined generally consisted of middle-achieving students or students from low socioeconomic regions; there was no study that examined the mental models of gifted students concerning the concepts of astronomy in a general context and the shape of the Earth and gravity in a more specific context. In addition, research has shown that students from different cultures have similar mental models or misconceptions, with some of these studies making various comparisons between different age groups. However, in the absence of research on gifted students, it is not possible to make comparisons with these students. In addition, research shows that students have different non-scientific mental models and difficulties with these abstract concepts. In this context, uncovering gifted students' mental models of Earth and gravity concepts and comparing them to previous research can provide guidance for teaching these concepts.

Since learning these fundamental concepts, including Earth and gravity, will facilitate future learning, it is important to identify students' mental models related to these concepts. Furthermore, the concepts of Earth and gravity are among the first concepts that elementary school students encounter in astronomy. Therefore, the purpose of this investigation was to determine the knowledge and mental models of gifted 2nd- and 3rd-grade elementary students regarding the shape of the Earth and gravity. The sub-problems of the investigation are, as follows:

1. What knowledge do gifted 2nd- and 3rd-grade students have about the shape of the earth and the concept of gravity?
2. What mental models do gifted 2nd- and 3rd-grade students have for the shape of the earth and gravity?

METHOD

Research Model

The research was conducted according to the basic qualitative pattern (Merriam, 1998, 2009). The aim of the research is to determine the mental models of gifted students about the shape of the earth and gravity. Qualitative research is a type of research that researchers can conduct using an interpretive approach (Merriam, 2009). The primary qualitative research design was used to understand the mental models of gifted elementary students regarding the shape of the earth and gravity concepts.

Participants

In the research conducted, criterion sampling based on purposive sampling was chosen to answer the research questions posed in the study. Purposive sampling methods focus on events and phenomena that shed light on a problem. This sampling method differs from the probability sampling method in terms of obtaining more in-depth knowledge (Patton, 2014). Therefore, this sampling method was preferred because the opinions of the gifted children were focused only because of the purpose of the study. In this context, the study was conducted with 80 students attending the 2nd and 3rd grades of a center for science and art in the Mediterranean region during the 2018-2019 school year.

Data Collection Instrument

Data were collected during the study through semi-structured interviews with the students, which consisted of open-ended questions. First, students were asked to answer the written questions with no time limit. Then, interviews were conducted with each student based on their answers and they were asked to explain the reasons for their answers. To prepare the interview

Table 1. Validity and reliability in research

Persuasiveness (internal validity)	Getting expert opinion
	Attendee confirmation
	Long-term interaction
	Direct quote
Transferability (external validity)	Description of data collection tool and process
	Explaining the data analysis process
	Explanation of the characteristics of the participants
	Explanation of the reason for choosing the method used
	Description of the researcher's role
	Indication of the method of selection of the working group
	Description of the implementation process of the study
	Explanation of validity and reliability measures
	Purposeful sampling
Consistency (internal validity)	Preventing data loss using the recorder
	Presenting the findings without comment
Confirmability (external reliability)	Appropriate discussion of the data in the conclusion
	Checking consistency between data

questions, the questions that Ozturk and Doganay (2013) translated into Turkish based on the studies of Hannust and Kikas (2007) and Vosniadou and Brewer (1992) were used. These three studies were used in preparing the interview questions.

The open-ended questions asked to the students in the study were, as follows:

1. What is the shape of the earth?
2. Can you draw the shape of the earth on paper?
3. Can you show where people are located on the shape of the earth you drew and what their posture looks like depending on their location?
4. If the people you drew had a ball in their hands and let go of the ball, can you draw where the ball would fall?
5. Can you draw where Turkey is located on the earth?
6. You left school and walked along a line in the same direction for days; where did you end up?
7. What is gravity? Have you heard of it before?

During the interview, additional questions were asked about the reasons for the students' answers.

Data Collection

Students were asked to answer the questions they would answer in writing, without a time limit on the form. In this process, the interviews were conducted by a researcher and the teachers. Students were then interviewed based on their answers and asked to explain the reasons for their answers. To explain their answers, they were asked questions about the reasons for their answers. The students' responses were also recorded using a tape recorder.

The survey, which lasted five-eight minutes with each student, was completed within one week. Each student comes to SAC for a total of two days in the afternoon, one day on a weekday, and one weekend in addition to their normal study location. Interviews were conducted during the first class periods on weekdays.

Analysis of the Data

The audio recordings of the interviews with the students were transcribed. Then, the written and postal responses were analyzed independently by two researchers using content analysis, codes and themes were created using Microsoft Excel, and inter-rater reliability was ensured. Reliability (reliability=consensus/consensus+disagreement) suggested by Miles and Hubermann (1994) was calculated to be 92%. Reliability calculations above 70% are considered reliable (Miles & Huberman, 1994). The result obtained here is considered reliable for research purposes. The reliability of the coding process is given. Then, considering all the answers given by the students, their mental models for the shape and gravity of the Earth were determined. In determining the mental models, the mental models in the literature were used as criteria.

Validity and Reliability

In qualitative research, validity and reliability are expressed with different concepts and methods. Instead of internal validity, persuasiveness is used, and instead of external validity, transferability is used. Internal reliability is explained by consistency and external reliability by confirmability (Erlandson et al., 1993; cited in Yildirim & Simsek, 2016). The details are provided in **Table 1**.

In order for the questions to be appropriate, understandable to gifted students, and serve the purpose of the research, expert opinions were obtained from two faculty members whose area of expertise is instructional pedagogy and one faculty member from special education. Based on these opinions, the pilot study was conducted with three students of the same age studying at the Science and Art Center in another province, and final arrangements were made for the interview questions. To make the students feel comfortable and give sincere answers during the interviews, some activities on different topics (GMO and energy resources) that were not the subject of the study were conducted by the researchers with the students for about two hours accompanied by their teachers.

Table 2. Findings regarding the shape of the Earth

The shape of the Earth	Theme	Code	f	%
2nd-grade	Circle	Round	16	40
		Circle	3	7.5
		Circle but ellipsoid	3	7.5
		A little round, a little oval circle	1	2.5
	Geoid	Geoid	2	5
	Sphere	Sphere	6	15
		Oval sphere	2	5
		Ellipse sphere	2	5
		Like a pressed ball	1	2.5
	Non-codable	No answer/no meaning	4	10
3rd-grade	Oblate sphere	Sphere, oblate the from bottom and top	3	7.5
		It is an oblate sphere	2	5
		An oblate sphere from the sides	1	2.5
		Bulged on the sides; slightly oblate from the tops	4	10
	Ellipse/circle	Ellipse	1	2.5
		Circle	1	2.5
		Ellipse and circle mixture	1	2.5
	Geoid	Geoid	4	10
	Sphere	Sphere	22	55
		Oval sphere	1	2.5

All three researchers analyzed the students' responses and interview transcripts separately in the data analysis. Inter-researcher harmony was calculated. The codes and themes used in this study aimed to ensure reliability by examining the rate of agreement between the two researchers.

The Role of Researchers

In the study conducted by three researchers, the first and second researchers conducted interviews with students. The second researcher transcribed the interviews. The first and third researchers conducted content analyzes and independently created codes and themes.

FINDINGS

In the research, the student's answers were analyzed based on the questions and findings for their knowledge of Earth's shape and gravity and their mental models based on the questions presented in this section.

Findings for the Research Questions of "What Knowledge Do Gifted 2nd and 3rd Graders Have About the Shape of the Earth and Gravity?"

The findings obtained from the questions "What is the shape of the Earth?" and "Can you draw the shape of the Earth on a paper?" are presented in **Table 2**.

When **Table 2** is examined, the 2nd-grade students' responses to the shape of the earth were grouped under the topics of circle, sphere, and geoid. On the topic of a circle, there are codes such as 40% round, 7.5% circle, and circle but ellipsoid, 2.5% slightly round, and slightly oval circle. On the topic of the geoid, the students answered 5%. For the sphere topic, a total of 27.5% of the responses were found for the codes sphere, oval sphere, elliptical sphere, and oblate sphere.

The responses of the third graders were grouped under the topics of a flattened sphere, ellipse/circle, geodes, and sphere. For the ellipse/circle theme, there are 7.5% equal codes for ellipse and circle-ellipse-circle mix codes. Under the sphere theme, the sphere code is 55% and the oval sphere code is 2.5%. Under the oblate sphere theme, there are 25% codes in total.

> S6 as a 2nd-grade student: "The shape of the Earth is the sphere. Maybe we can say it is like a ball, but a slightly different ball is like a ball stepped on..."

> S45 among the 3rd-grade students: "The shape of the Earth is geoid. The geoid is like a sphere, but it is a slightly oblate sphere from the top and bulging at the sides which we call geoid. He explained his thoughts in his form."

Findings for "can you show where people are located on Earth, and what their postures will be according to their locations? Can you draw it?" are presented in **Table 3**.

When **Table 3** is examined, it has appeared that in the 2nd-grade, the proportion of codes for the science theme people all over the world was 15% and the proportion of codes for people on the continents of the world was 25%. The alternative theme comprised 55% of the codes (15% people on top of the world, 15% of people outside the world, only on top, 10% on the barren outer hill of the world, 15% on the apartment ground). Third graders' responses were 77.5% recorded for the scientific theme and 17.5% recorded for the alternative theme.

Table 3. Findings regarding where and how people are located on the Earth

Where and how are people located on Earth?	Theme	Code	f	%
2nd-grade	Scientific	People all around the world	4	10
		On continents on earth	10	25
	Alternative	At the summit of the Earth	6	15
		Outside the world, just people on top	6	15
		Empty round outer top	4	10
		Men on flat ground	6	15
	Non-codable	I do not know	4	10
3rd-grade	Scientific	Continents and countries	3	7.5
		Continents	5	12.5
		On continents (on mainlands)	19	47.5
		Earth with mainlands, men all-around of it	4	10
	Alternative	There are continents, but people are in the top zone	4	10
		Top of the world	2	5
		People on flat ground	1	2.5
	Non-codable	No meaning	2	5

Table 4. Findings regarding the effect of gravity

Where does the ball fall?	Theme	Code	f	%
2nd-grade	To the ground	Falls to the ground	28	70
		Flat ground falls to the ground	1	2.5
		Falls to the continent than to the ground	2	5
	Outer earth	To the black hole	1	2.5
	Non-codable	No meaning	8	20
3rd-grade	To the ground	Falls to the ground	30	75
		To the head of the person who threw it	1	2.5
		Towards the center of the world	3	7.5
		Falls to the continent than to the ground	4	10
	Outer earth	Deep into space	1	2.5
	Non-codable	No answer	1	2.5

> S15, as one of the gifted 2nd-grade students, “People live on top of the earth, and the top of the earth is like this, we can say that the top is here.” S52 from 3rd-grade, drawing straight lines, explained that they live here like this.

The results of the analysis of students’ responses to the questions “If the people you are drawing had a ball in their hands and left the ball, would you draw where the ball would fall? Can you draw it?” are included in **Table 4**.

The 2nd-grade students’ answers to the questions and the 3rd-graders’ answers were also collected under the themes of earth and outer earth. However, their proportions were different. While 77.5% of the codes were found under the Earth theme for the 2nd-grade students, 20% of the answers could not be coded or were meaningless. In the 3rd-grade, 95% of the codes were recorded under the theme Earth.

> S21: One of the gifted 2nd-grade students: “If the person holding the ball throws it, it can fall upwards on the person’s head. Then the ball will bounce on the ground and stay on the ground...” S46 from 3rd-graders: “Because it is on top of the world, the ball will disappear from here, where it can go, for example, I think it goes deep into space... “

“Where is the place where we live on earth? Can you draw where Turkey is located on Earth?” The answers of the gifted 2nd- and 3rd-year students were analyzed and the results are presented in **Table 5**.

When **Table 5** was examined, 2nd-grade students’ responses to the questions on the Earth as a habitat, small Turkey, Turkey in the northeast, and separate Turkey were collected. 40% of the 2nd-grade students positioned their place of residence as beautiful and central in the world. Those who described Turkey as close to reality were 7.5% on the topic of Turkey in the northeast.

Table 5. Findings regarding “Where is Turkey?”

Where is Turkey?	Theme	Code	f	%
2nd-grade	Earth as a place for living	The Earth and massive Turkey	4	10
		Alanya is huge	3	7.5
		Turkey is a single continent	3	7.5
		Turkey is a single continent among many continents	6	15
		Turkey in the middle of the world	4	10
	Small Turkey	Turkey showed with a point on a single continent	3	7.5
	Turkey in the northeast	Continents on the Earth & Turkey with approximate location & size	3	7.5
	Separate Turkey	Map of Turkey drawing	7	17.5
	Non-codable	I do not know	5	12.5
		No meaning	2	5

Table 5 (Continued). Findings regarding "Where is Turkey?"

Where is Turkey?	Theme	Code	f	%
3rd-grade	Earth as a place to be lived	Only big Turkey on the Erath	3	7.5
		Turkey is in the middle of continents and the World	1	2.5
		Continents and one continent Turkey	7	17.5
	Single continent the World	Single continent world and Turkey within it	1	2.5
	Small Turkey	Turkey showed with a point	1	2.5
		Small Turkey among continents	2	5
		Continent among other continents and Turkey at the end	1	2.5
		Continents and Turkey in the south	1	2.5
	Separate Turkey	Map of Turkey drawing	1	2.5
	Non-codable	I cannot draw	1	2.5
	Turkey in the north	Empty the Earth and map of Turkey in the northeast	2	5
		Continents and Turkey in the northeast	6	15
		Continents and Turkey in the north	12	30
		Poyrik country and Turkey in the northeast	1	2.5

Table 6. Findings based on question "Where do I get to?"

Where do I get to?	Theme	Code	f	%
2nd-grade	To out of the World	To infinity	2	5
		Into a space	2	5
		To the Mars	1	2.5
	Scientific	To the same place again- school	20	50
	To a different place in the world	To a house, park-mountains-forest	8	20
		To the end of Turkey	3	7.5
		Istanbul	1	2.5
	Non-codable	I do not know	2	5
		No meaning	1	2.5
3rd-grade	Scientific	Back to the same place–to starting point-to-school	31	77.5
	To a different place in the world	To the middle of the road	1	2.5
		To the east	1	2.5
		To Van	1	2.5
		To Hakkari or Syria	1	2.5
		I will hit the wall	1	2.5
		To the forest-mountain-park	4	10

The responses of the third graders were collected under four codes, 52.5% on the topic of Turkey in the north, 10% on the topic of Small Turkey, 2.5% on the topic of separate Turkey, and 27.5% on the topic of the Earth as a place to live.

The results obtained from the answers to the question "You left school and walked for days in the same direction along a line, where did you arrive?" are shown in **Table 6**.

Table 6 shows that the 2nd-grade students' responses are 12.5% on the "outside the world" theme, 50% on the "scientific" theme, and 30% on the "to another place in the world" theme. 3rd-grade students' responses are 77.5% on the theme of science and 22.5% on the theme of another place in the world.

> Participant 7: "I would be exhausted if I walked for days, but if I rest and continue, I will go to different places and go to the end of Turkey, and then I think I will reach other countries...."

> S10, among 2nd-grade students: "If I walk for days, I will travel a lot straight, but I will come here again in the end, so to the school again because the world is round..."

> S48 as a 3rd-grade student: "If I walk straight in the same direction for days, I will reach different countries, for example, I will reach Syria first, I think there may be other countries afterward...."

The answers to the questions "What is gravity? Have you ever heard of it? Can you explain it to us?" from gifted 2nd and 3rd-year students were analyzed and the results are presented in **Table 7**.

In analyzing the 2nd-grade students' responses to the questions presented in **Table 7**, 27.5% of the responses for gravity were collected under the theme *the thing that keeps things on the ground* and 10% were collected under the theme *the thing that pulls us to the ground and keeps us on the ground*. 3rd-graders' responses were collected 15% under the theme "falling," 27.5% under the theme "pulling away from the ground," 2.5% under the theme "Newton," 22.5% under the theme "the thing that keeps things on the ground," 5% under the theme "flying," and 12.5% under the theme "from the center of the earth." 20% of 2nd-graders and 2.5% of 3rd-graders said they had never heard of this concept.

> S14 from 2nd-grade students on the topic of gravity: "Gravity makes things fall to the ground; for example, if I do not hold my notebook while I am carrying it, it falls to the ground, that's gravity..."

Table 7. Findings based on "What is gravity?"

Gravity	Theme	Code	f	%
2nd-grade	The thing that keeps things on the ground	It is to be on the ground	5	12.5
		The thing that enables things to stand stop	2	5
		Walking on the floor	1	2.5
		If it did not exist, we would be flying through the air	1	2.5
		It is what keeps people on land	2	5
	The pulling thing	It is what pulls us to the ground	3	7.5
		It is what pulls us down	1	2.5
	Falling to the ground	The law that enables things to fall to the ground	3	7.5
		It happens when something falls to the ground	1	2.5
	Hearing	I just heard	13	32.5
	Non-codable	No answer/I do not know	8	20
3rd-grade	Falling	Not falling of people under the Earth	3	7.5
		Items falling to the ground	3	7.5
	The pull of the ground	The pulling power	7	17.5
		It is the ground pulling us	4	10
	Newton	Isaac Newton found it	1	2.5
	The thing that stops things on the ground	It is when people can stand on the ground	6	15
		The thing that enables things to stand up & stay on the ground	3	7.5
	To fly	It lets us not jump into space	1	2.5
		If it did not exist, we would be flying through the air	1	2.5
	The one coming from the center of the Earth	The magnet in the world that holds us	1	2.5
		The gravitational pull of magma core	2	5
		Force applied from the center of the world	2	5
	No information	I heard	5	12.5
		I did not hear that	1	2.5

S29: "People walk on the ground because of gravity, this is gravity... "

S43 as a 3rd-grade student: "I heard about gravity, Isaac Newton discovered it. However, I do not know exactly what it is..."

S46: "I heard about gravity; the Earth has magma inside it which attracts everything to the center of Earth... They expressed what they knew about gravity by these expressions."

Findings on the 2nd Sub-Problem of the Research Regarding the Mental Models of Gifted 2nd- and 3rd-Grade Students for the Shape of the Earth and Gravity

In the study, as a result of the analysis of the answers given by the students in the interview form and the analysis of the interviews with the students, the mental models regarding the shape of the Earth and gravity were created for each student.

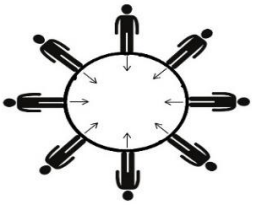
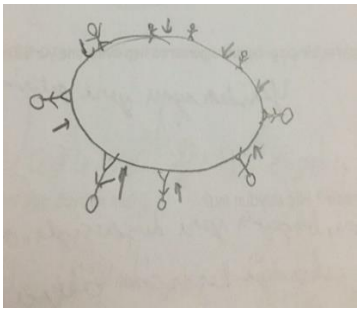
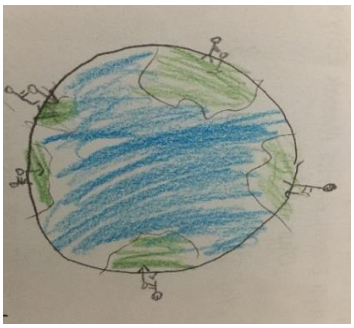
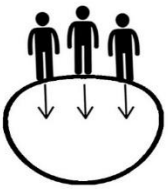
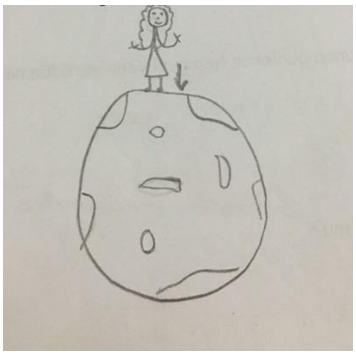
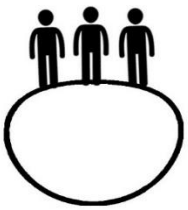
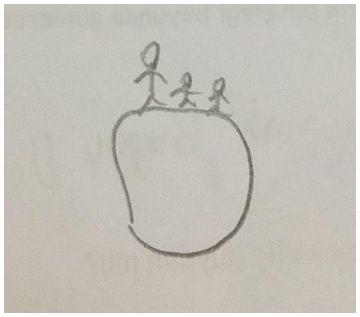
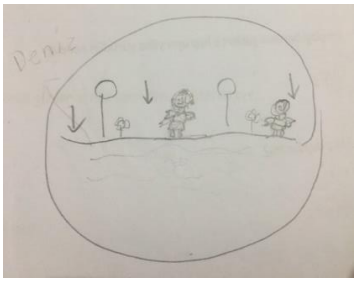
Looking at the mental models in **Table 8**, in the first mental model the Earth is spherical and people live in the outer part of the Earth. Gravity is everywhere directed toward the center of the earth. In the second mental model, the Earth is spherical and people are on the surface of the Earth. Gravity is directed toward the center of the Earth. These two models of the students were determined as the scientific models. In the 3rd mental model, the shape of the world resembles a sphere. People live at the top of the earth, and gravity runs from north to south. In the 4th mental model, the shape of the world resembles a sphere. People live at the top of the earth. There is no information about gravity. In the 5th alternative model, the world looks like a sphere. People live inside the world. Gravity runs from north to south.

It can be noted that gifted 2nd-grade students have two scientific models and three alternative models. The total percentage of students with two scientific models is 45%, and the percentage of students with alternative models is 55%. For 2nd-grade students, the three alternative models are 25%, 25%, and 5%, respectively. Gifted 3rd-grade students have two scientific models and two alternative models. The percentage of students with scientific models is 77.5%, with a total of 31 students, while nine students (2.5%) have alternative models.

CONCLUSION, DISCUSSION, AND SUGGESTIONS

The study analyzed the opinions of gifted 2nd- and 3rd-graders about the shape of the Earth and gravity and identified and compared their mental models. Accordingly, most 2nd grade students expressed the shape of the world as round and referred to the world with two-dimensional shapes such as circles, etc. The models that some students created with the shapes they expressed and the shapes of the world they drew differed. For example, it was found that the student who described the shape of the world as oval drew a more elliptical shape in his drawings. It can be said that students have problems embodying such concepts. The third graders, on the other hand, illustrated the shape of the world with three-dimensional concepts than the second graders, and the shapes they drew and their models proved to be more consistent. In terms of where people live in the world, the 2nd-grade students described the earth as round and depicted the place where they live as apartment ground, showing that they cannot connect the world they live in with the world they learn about in school.

Table 8. Mental models for the concepts of the Earth's shape and gravity

Mental models	Mental model	Example of student drawings
1st scientific model: The Earth in the shape of a sphere People around the Earth Gravity towards the center of the Earth everywhere		
2nd scientific model: The Earth in the shape of a sphere People on the surface of the Earth Gravity towards the center of the Earth		
3rd scientific model: The shape of the World looks like a ball People live at the top of the Earth Gravity from north to south		
4th scientific model: The shape of the World looks like a ball People live at the top of the Earth There is no information on gravity		
5th alternative model: The shape of the World looks like a ball People live within the world Gravity from north to south		

	f	%		f	%
2nd-grade	8	20	3rd-grade	13	32.5
2nd-grade	10	25	3rd-grade	18	45
2nd-grade	10	25	3rd-grade	7	17.5
2nd-grade	10	25	3rd-grade	2	5
2nd-grade	2	5	3rd-grade	-	-

In analyzing the drawings of the gifted students, it was found that most students had difficulty approximating where they lived. This rate is much higher in 2nd-graders than in third graders. The majority of second graders were found to represent the center of the world as to where they lived or to draw the earth in a much more significant way. One-third of the second graders could not indicate their place on Earth or draw a map of Turkey separate from the world, and they could not place Turkey's place in the world. More than half of the third graders could more realistically depict the place they live on Earth. Some students represented the countries they have seen in computer games and fairy tales in their drawings, although the proportions are not so great. In this regard, this result is similar to Ozsoy's (2012) research findings. This result is an example of students accepting places in computer games and fairy tales as if they were real.

Regarding the place students would reach if they walked straight for days, more than half of 2nd-graders and almost three-quarters of 3rd-graders indicated that they would reach the same place, while some of the second graders indicated that they could go out of the world and be able to reach specific destinations in a more limited way. 3rd-graders do not indicate that they could go out of the world, but they believe that limited concrete destinations could be reached, such as parks, mountains, forests, or another country. These results can be taken as further evidence that students have conflicting beliefs that the world is round. This supports the assumption in the literature (Hannust & Kikas, 2007; Kikas, 1998) that young children's conceptual understanding of how the natural world works is based on their daily observations and shaped by informal learning experiences.

Regarding the effects of gravity, both second and third graders largely agreed that a ball falls to the ground when a child lets go of it. However, some students indicated unrealistic alien locations and meaningless positions. Second graders were found to display more unrealistic and meaningless locations and positions than third graders. The number of gifted 2nd-grade students who indicated they had only heard of gravity and who indicated they did not know gravity was more than half of the students. This percentage is lower for 3rd-grade students. In addition, the 2nd- and 3rd-grade students' ideas about gravity generally revolve around the word "place", but they indicated the effects of gravity. It was also found that some students stated the result of gravity as the cause. In general, it can be said that they have heard about the concept of gravity, but there are deficiencies in their knowledge of the concept of gravity in scientific understanding. This is due to the fact that in secondary education, information about this concept is provided in the teaching programs when students are exposed to the concept of gravity. Ozturk and Doganay (2013) also highlighted this problem. In this regard, it is believed that the 2018 science instructional program, similar to the 2005 science instructional program, could be another reason for these knowledge deficits among students since the concepts of Earth and gravity are offered separately in later years. As a result of the study, it was found that the knowledge of the gifted third graders about the shape of the Earth and the concepts of gravity was better than that of the second-grade students. This study result is similar to the research findings of Ozturk and Doganay (2013) and Vosnyadou and Brewer (1992).

As the grade level increased, so did the students' knowledge level. This result is due to the fact that they processed the topics related to the shape of the world in 3rd grade in accordance with the science teaching program. Third graders can think more abstractly cognitively than second graders, so this may be a factor in them having a better level of knowledge. However, another finding of the study is that gifted third graders also have an unscientific understanding of the shape of the Earth.

The study also found that gifted second graders had five different mental models regarding the shape of the Earth and gravity, two of which were scientific and three of which were alternative, while gifted third graders had two scientific and two alternative mental models. Gifted third graders had more scientific mental models than second graders. One of the alternative mental models that students have is that students form the world in their minds as a sphere, but flatten the top part of the world due to the effect of apartment world perception. This model was also found in Baxter's (1989) study conducted with students aged 9 to 16 and Ozturk and Doganay's (2013) study conducted with fifth and eighth-graders. In this model, students pictured gravity from north to south. In another mental model, students flattened the top but did not represent gravity and its effects. Previous research has found no such mental model when the relevant literature is examined. In the third alternative mental model, people live inside the world, and gravity is represented from north to south. This model is one of the models identified in the studies of Nussbaum (1979) and Ozturk and Doganay (2013).

This study shows that gifted students have a better level of knowledge and a higher rate of scientific mental models related to the shape of the Earth and gravity than the studies conducted in the literature with other students. However, Bryce and Blown (2006), Nussbaum (1979), Sadler (1992), and Vosniadou and Brewer (1992) also found that students have unscientific mental models related to the shape and gravity of the Earth and that the proportion of these models decreases with increasing educational level. Gifted 3rd-grade students were found to have a higher proportion of scientific mental models than 2nd-grade students, and this finding may be due to the effects of 3rd-grade students' learning experiences in science class. When examining the science curriculum, it is clear that the first unit aims to provide students with information about the shape and structure of the Earth in three weeks (Ministry of National Education [MoNE], 2018).

In order for gifted students' mental models about the shape of the world and the concept of gravity to become more scientific, it is believed that their teaching could be more effective if these topics are included in the content of science teaching programs in a more interconnected form. Because the concept of gravity is covered in seventh-grade science classes, it is assumed that students develop alternative concepts by this grade level, which was a major factor in the inability to recognize students' mental models regarding the effects of gravity. Therefore, although the concept of gravity is abstract in the instructional programs, it can be incorporated into the instructional content in the lower grades where students begin to think concretely. Because gravity is an abstract concept, it is believed that the use of three-dimensional models in the design of classroom situations and videos, animations, and simulation applications can facilitate student learning and be more effective in creating more scientific mental models. To this end, researchers can conduct experimental studies using teaching methods that are believed to be effective in teaching the concepts of the shape of the world and gravity. There is little research on astronomy in the literature. The research to be conducted will contribute to the literature.

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