e-Kafkas Journal of Educational Research e-KJER Research Article

Determination of Gifted Middle School Students' Mental Models of Earthquake

Güliz Kaymakcı[1] Cüneyd Çelik[2] Meryem Görecek Baybars[3]

To cite this article:

Kaymakcı, G., Çelik, C. & Görecek Baybars, M. (2023). Determination of Gifted Middle School Students' Mental Models of Earthquake. *e-Kafkas Journal of Educational Research, 10,* 1-17. doi:10.30900/kafkasegt.1201217

Research article **Received:**08.11.2022 **Accepted:**14.03.2023

Abstract

This study aims to determine the mental models of gifted middle school students about an earthquake. The study employed the phenomenological design. In this context, the study was conducted on 41 students having gained the status of gifted students are results of the exams conducted by Science and Art Centres (BİLSEM) in three different provinces of Turkey. In these centres, gifted students, are diagnosed and can recognize their areas of special talent and get education to develop these areas in addition to the formal education they receive in their schools. In the current study, the "Earthquake Mental Model Test" was developed by the researchers in order to determine the mental models of the gifted students about the concept of an earthquake. According to finding mental models of the 41 gifted students are gathered under the mental models of natural disaster-energy-destruction (f=1), natural disaster-earth's crust movement-destruction (f=6), natural disaster-destruction (f=2), energy-protection (f=1), quake (f=4), quake-destruction (f=16), earth's crust movement (f=2), earth's crust movement-protection (f=1) and earth's crust movement-destruction (f=8). According to the findings obtained, the mental models of the students regarding the earthquake are gathered under the themes of Natural disaster-energy-destruction model. Natural disaster-energy-destruction model: Natural disaster-earth's crust movement-destruction model, Natural disaster-destruction model, Energy-protection model, Quake model, Quake-destruction model, Earth's crust movement model, Earth's crust movement-protection model and Earth's crust movement-destruction model.

Keywords: Mental models, earthquake, gifted students, middle school students

[1] Tokat Gaziosmanpasa University, Faculty of Education, gulizkaymakci@gmail.com
[2] Mugla Sıtkı Kocman University, Faculty of Education, Science education
[3] Mugla Sıtkı Kocman University, Faculty of Education, Science education

Introduction

Natural disasters are natural events that can be of natural, technological or human origin, causing physical, economic and social loss of human beings and damaging nature (Turan & Kartal, 2011). In other words, disaster can be defined as the injury of living things and the loss of life and property in the face of a risky or dangerous situation that arises as a result of changes in the physical structure of the earth (Kasapoğlu & Ecevit, 2001). Events such as floods, landslides, volcanic eruptions, avalanches and earthquakes are considered to be natural disasters (AFAD, 2022). Earthquake is one of the most commonly experienced natural disasters in Turkey because Turkey is located in the Alpine-Himalayan seismic belt, which is one of the most important earthquake belts in the world. The Anatolian Plate, on which Turkey is located, is surrounded by the Eurasian Plate in the north, the African and Arabian Plate in the south, the Eastern Anatolian Block in the east and the Aegean Block in the west. Due to this tectonic location, almost all of Turkey's lands are at risk of earthquakes (Bikçe, 2015).

Also, disasters are known to cause other disaster. For this reason, they are discussed multi-dimensionally in the literature in terms of their effects. Earthquakes are also a good example of this; an earthquake can trigger many different disasters such as fire, explosion, environmental pollution and flooding (Kadıoğlu, 2011). The formation process of earthquakes includes more complex processes than many other disasters. For this reason, it is more difficult to understand how earthquakes occur. Earthquake is defined as the shaking of the environment and the ground surface with vibrations that occur suddenly due to the breaks in the earth's crust (Babüroğlu, 1998). It is one of the disasters that can even destroy continents (Akyel, 2000). One-fifth of the earthquakes that occur every year in the world occur on the Mediterranean-Alpine-Himalayan seismic belt, which includes 93% of Turkey's territory (The Union of Chambers of Turkish Engineers and Architects [TMMOB], 2012). Therefore, earthquakes that occur at frequent intervals are one of the natural events that cause the most loss of life and property in Turkey (AFAD, 2018). Land pieces with different thicknesses and densities make up the Earth, or in other words, the plates are in a constant state of equilibrium depending on the movement of the mantle layer. Fractures in the earth's crust are called 'faults'. Faults are formed by the compression and breaking of rocks under high pressure. Due to the hot and fluid nature of the magma layer under the earth's crust, stress-related slips or new fault fractures occur in the fault fractures. This causes sudden vibrations and the formation of shock waves on the plates. These shock waves spreading throughout the earth's crust are also called earthquake waves. The severity of earthquake waves can reach very large sizes depending on the intensity of the shock waves (Watt, 2010).

Although it is not possible to prevent the occurrence of earthquakes with today's technology, it is possible to reduce the damage caused by the earthquake through education (Navakanesh, Shah & Prasanna, 2019). It has been accepted by almost all countries that earthquake education given in schools is very effective in raising earthquake awareness, and earthquake-related topics are included in different courses in the current primary and secondary education curricula (Demirci & Yıldırım, 2015). Earthquake education in Turkey is given at every grade level from the first to the fourth grade of primary education under the name of disaster education to inform students about the effects of earthquakes, precautions to be taken against earthquakes, and earthquake preparedness. In middle school, students are educated about the causes of earthquakes, formation of earthquakes, some concepts related to earthquakes and earthquake protection methods in both science and social studies classes given at all grade levels (MoNE 2013a; MoNE, 2013b).

When the literature is reviewed, it is seen that there are many studies conducted with the participation of middle school students on the subject of the earthquake. After the earthquake that took place in Van in 2011, the effect of the earthquake on the social values of the students was examined in the study conducted with the participation of 455 students in the eighth grade (Akbaba, Kılcan & Çepni, 2013). In the study, which was carried out in the survey model using the Changing Values Form, it was determined that the values such as responsibility, solidarity, giving alms, peace, honesty and patriotism came to the fore in the students who experienced and did not experience the earthquake. In the study conducted by Aydın (2010), it was aimed to reveal the perceptions of 480 eighth-grade students attending schools in Ankara, Antalya and Karabük about the concept of earthquake. For this

purpose, a semi-structured interview form consisting of short and open-ended questions was used. As a result of the study, it was determined that the students generally perceived the earthquake as the collapse of buildings and the death of people, energy discharge due to plate movements, a natural disaster, shaking of the ground, tremors due to the movement of the earth's crust and fault lines, and a disaster whose harms can be reduced if necessary precautions are taken. In another study, the daily knowledge of middle school students studying in the city of Columbus in the USA, where the earthquake risk is low, and Aydın, where the earthquake risk is high, and their way of thinking about earthquakes was determined (Oğuz, 2005). A total of 506 middle school students from Turkey and 317 from the USA participated in the study. According to the results of the study, while there was no significant correlation between the ages of the students in Turkey and their knowledge about earthquakes, the knowledge of the students from the USA increased in proportion to their age. Ross and Schuell (1993) aimed to reveal the views of 91 middle school students who experienced and did not experience earthquakes based on their own experiences. While most of the students expressed the earthquake as a ground shaking, some students explained the earthquake by associating it with a volcanic eruption, core movement, thunder, rain, wind, mountains and the Sun heat. Thus, it is seen in the literature that studies on the subject of the earthquake are generally carried out on mainstream middle school students.

Since our country is located in an earthquake zone, it is important to raise awareness among future generations about earthquakes. Today, the understanding of carrying out remedial activities after earthquakes has left its place to the understanding of taking precautions and risk management. The priority in taking precautions against earthquakes and in risk management is to raise conscious individuals. It is thought that it is very important to determine the current mental model of gifted students (Camcı, 2011), who are thought to be more likely to have a career tendency with their awareness at a young age and to look at current issues from a different perspective (Camcı, 2011), about the phenomenon of earthquake. In this way, damages can be minimized with practical and permanent solutions proposed by the damages that may occur in the event of a possible earthquake, by designing an effective earthquake education and raising awareness among students, as in countries such as Japan where earthquakes are frequently experienced (Başıbüyük, 2004).

Gifted individuals are individuals who differ from normal individuals in terms of the distribution, frequency, timing and combination of physical, mental, social and personality traits (Akarsu, 2004). Gifted individuals have many superior characteristics compared to their peers. The characteristics of these individuals were listed by Çağlar (2004) in our country and by many researchers abroad. When these characteristics are examined, it is seen that there are characteristics such as "transferring knowledge to and using it in the best way in new situations, having deep and broad interest and knowledge in many fields". It is also thought that the investigation of the mental model of gifted middle school students will contribute to the design process of earthquake education within the scope of an enriched science education to be created for these students. In addition, this study aims to determine the mental models of gifted middle school students about earthquake. Mental models are internal representations of real situations in the minds of individuals to make sense of and comprehend events and phenomena in the world (Franco & Colinvaux, 2000). Mental models are a symbol of knowledge, indirect, unfinished, idiosyncratic, functional, and reflect people's beliefs (Günbatar & Sarı, 2005). It grows and evolves with the addition of new information. It provides the individual with the opportunity to explain and reason about the phenomenon he/she wants to express (Ünal & Ergin, 2006). When the knowledge and experiences of individuals are considered, it is seen that their mental models are of great importance. As each individual's cognitive processes differ, mental models can be used to determine how they learn information (İyibil & Arslan, 2010). To this end, answers to the following questions are sought:

1. What is the mental model of gifted middle school students regarding earthquakes?
2. Does the mental model of gifted middle school students about the concept of earthquake vary depending on their state of experiencing an earthquake?
3. Does the mental model of gifted middle school students vary depending on their source of information on earthquakes?
4. Does the mental model of gifted middle school students vary depending on their gender?

5. Does the mental model of gifted middle school students vary depending on their city of residence?

Method

The current study employed the phenomenological design. Phenomenology is seen as a suitable research ground for studies that aim to investigate phenomena that are not completely foreign to us and that we can not fully comprehend (Yıldırım & Şimşek, 2006). "Earthquake" is one of the phenomena that we encounter frequently and that we experience frequently throughout the world, even if we do not experience it directly. For this reason, it is thought that the chosen method is suitable for the nature of the study.

Study Group

The sample group of the current study was determined by using criterion sampling, one of the purposive sampling methods. In this study, the criterion used to select the sample was that the cities where the science and art centre (BİLSEM) schools are located are in the 1st - degree earthquake zone. In this context, the study was carried out with the participation of students who gained the status of gifted students in the exams held by BİLSEM from three different cities of Turkey in the second semester of the 2021-2022 school year. Under the rules of this institution, the cities from which the students were selected for the sample were kept confidential. Instead, codes were used to represent the cities where the students in the sample resided (1st city, 2nd city and 3rd city). The BİLSEM schools included in the sample of this study are in the provinces located in the 1st - degree earthquake zone and 18 of the gifted students continue their BİLSEM education in the painting talent group and 23 in the general talent group. The characteristics of the study group is presented in Table 1.

Table 1.
Specification of the Study Group

Cities	Grade Levels	N	Total
1st City	5th Grade	5	
	6th Grade	5	11
	7th Grade	1	
2nd City	5th Grade	10	
	6th Grade	1	11
	7th Grade	-	
3rd City	5th Grade	13	
	6th Grade	3	19
	7th Grade	3	
Gender	Girl	18	41
	Boy	23	

In the study group, there are 11 students from the 1st city, 11 students from the 2nd city and 19 students from the 3rd city. On the other hand, there are 28 fifth graders, 9 sixth graders and 4 seventh graders in the study group. Of the students participated, 18 are girls and 21 are boys.

Data Collection Tool

When the relevant literature is reviewed, it is seen that there are different data collection tools used to determine mental models. These data collection tools can be open-ended questions that require explanation and drawing, as well as multiple- choice questions and interviews (Chia- Yu, 2007). In the current study, the "Earthquake Mental Model Test" was developed by the researchers in order to determine the mental models of the gifted students about the concept of earthquake. This form consists of two parts. In the first part, there are questions that determine the demographic characteristics of the students, and in the second part, there are three open-ended questions to determine the mental models of the gifted students about the concept of earthquake. In other words, in the second part, the student answers questions requiring drawing and explanation about the concept of earthquake. The data collection tool is shown in Appendix 1. In order to check the suitability of the data collection tool for the study, the opinion of an expert in the field of physics education was sought. In line with the expert opinion, necessary corrections were made to the data collection tool, and the data collection tool was

finalized. Thus, the final data collection tool consisted of two parts. The first part consists of 4 questions to determine the demographic characteristics of the students, and the second part consists of 3 open-ended questions to reveal the mental models of the students about the concept of earthquake. The first and second open-ended questions are asked to be answered in writing and the third question by drawing.

Data Collection

A pilot study was conducted by applying the data collection tool to 15 gifted middle school students different from the ones in the study group. With the pilot study, it was checked whether the questions were comprehensible, and the time required to complete the data collection tool was determined. As a result of the pilot study, it was determined that one class hour would be sufficient for the students to complete the data collection tool. During the actual implementation process, first of all, BİLSEM administrations in the cities were contacted and necessary permissions were obtained for the application of the data collection tool (Final decision of Tokat Gaziosmanpaşa University Social and Human Sciences Research Ethics Committee's meeting dated 27/04/2022, the session number is 07 and the decision number is 01-62).

Data Analysis

Before moving on to data analysis, the papers of the students were coded. Coding analysis in qualitative studies is very important as it guides the next stages (Ragin, 1995). Codes are guiding tags for data. Most researchers can give different and unique names to the sets of codes. With this feature, coding should be able to address both the researcher and other researchers who may be involved in the research. In the current study, "S" represents the student and the number represents the student's rank in the coding. For example, the code "S7" refers to the 7th student. In the data analysis, first of all, the papers belonging to the students were handled as a whole; all of the data were read and examined. At this stage, no coding was performed by the researcher. Thus, the researcher had the opportunity to think deeply. After this stage, the data were analyzed and thematic content analysis was used in the data analysis. The analysis of the data was carried out by two coders (Coder 1 and Coder 2) who are experts in the field of science education. The first and second questions in the second part of the data collection tool are about description and the third question is about visualization. While determining the mental models of the students about the concept of earthquakes, three questions were evaluated together.

Since there is no study in the literature to determine the mental models of individuals about earthquakes, the themes were created by considering the answers given by the students to the questions in the second part of the data collection tool. Information on these themes is given in Table 2.

Table 2.
Themes of the Mental Models on the Concept of Earthquake and Explanations Corresponding to These Themes

Theme	Explanation
Natural disaster-energy-destruction model:	While an earthquake is described as a natural disaster, it is described in writing that energy is effective in the formation of an earthquake, and there are images of destruction in the visual images.
Natural disaster-earth's crust movement-destruction model:	While an earthquake is described as a natural disaster, it is described in writing that the earth's crust is effective in the formation of an earthquake, and there are images of destruction in the visual images.
Natural disaster-destruction model:	While an earthquake is described as a natural disaster, there are images of destruction in the visual images.
Energy-protection model:	While the occurrence of an earthquake is associated with the concept of energy, images related to the ways of protection from an earthquake are included in the drawings.

Table 2 continuing

Quake model:	The concept of a quake is included in both written and visual descriptions.
Quake-destruction model:	While both written and visual descriptions include quakes, there are also images of destruction.
Earth's crust movement model:	In both written and visual descriptions, earthquake is associated with the movement of the earth's crust.
Earth's crust movement-protection model:	Written descriptions contain explanations about the movement of the earth's crust, while visual images include ways of protection from earthquakes.
Earth's crust movement-destruction model:	Written descriptions contain explanations about the movement of the earth's crust, while visual images contain images of destruction.

One of the important stages of qualitative data analysis is the confirmation of the findings. Confirmation of findings can be accomplished by testing and validating the results obtained (Merriam, 1998). At this point, there are various ways that the researcher can follow. The coding of the same data set by different field expert coders and the similarity ratio of the consistency in the codes of these coders is one of them. This similarity ratio supports reliability in qualitative research. According to Miles and Huberman (1994), an agreement between coders should be at least 80%. In this connection, the compatibility of the codings made by two researchers for the same data set was checked. Accordingly, the analyzes of coder 1 and coder 2 were consistent in 37 of 41 students and inconsistent in our students. Thus, it can be said that there is a 90% agreement between the coders (Miles and Huberman, 1994). In order to minimize the disagreement between the coders, the data were examined with the joint participation of coder 1 and coder 2, and the sources of the disagreement were identified and resolved.

Findings

In the current study, the mental models of the gifted middle school students about the concept of earthquake were examined and the findings are presented in the tables below. In addition, examples of student drawings and explanations are given in the findings section

Findings of the First Research Question

It was tried to determine the mental models of the gifted middle school students about earthquake. The written and visual descriptions of the students were analyzed by using thematic content analysis. The obtained findings are presented in Table 3.

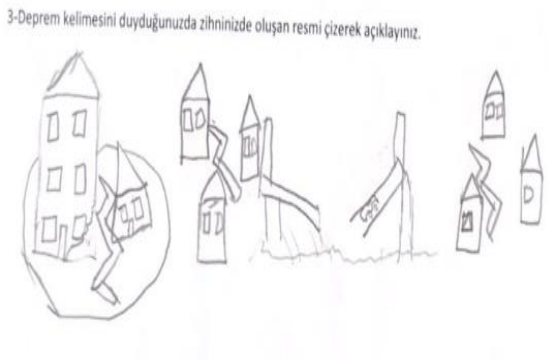
Table 3.
Mental Models of the Gifted Middle School Students about Earthquake

Models	f
Natural disaster-energy-destruction model	1
Natural disaster-earth's crust movement-destruction model	6
Natural disaster-destruction model	2
Energy-protection model	1
Quake model	4
Quake-destruction model	16
Earth's crust movement model	2
Earth's crust movement-protection model	1
Earth's crust movement-destruction model	8

When Table 3 is examined, it is seen that the mental models of the 41 gifted students are gathered under the mental models of natural disaster-energy-destruction (f=1), natural disaster-earth's crust movement-destruction (f=6), natural disaster-destruction (f=2), energy-protection (f=1), quake (f=4), quake-destruction (f=16), earth's crust movement (f=2), earth's crust movement-protection (f=1) and earth's crust movement-destruction (f=8). In addition, according to the mental models of the students,

it is thought that the mental model related to the ways of protection from earthquakes (f=2) is not given enough attention. Sample student answers are given in Table 4.

Table 4.
The Drawing Produced as A Response to the 3rd Question

Drawing	Student Answers
	*S14 / Quake-destruction model* The answer given to the 1st question: "As a result of the shaking of the ground, the living and non-living beings above feel this vibration." The answer given to the 2nd question: "Earth's crust quakes and collides with other crusts of Earth."
	S6 / *Natural disaster-energy-destruction model*: The answer given to the 1st question: "Earthquake is a natural disaster and ground shaking." The answer given to the 2nd question: "The fluctuations that come as a result of the energy that suddenly emerges in the earth's crust and the shaking of the earth by these fluctuations."
	*S25 / Natural disaster-earth's crust movement-destruction model*: The answer given to the 1st question: "Earthquake is a natural disaster that can cause loss of life and property." The answer given to the 2nd question: "It is caused by shaking in the earth's crust."

Findings of the Second Research Question

It was tried to determine how the mental models of the gifted middle school students on the concept of earthquake vary depending on the state of experiencing an earthquake. The written and visual descriptions of the students were analyzed by using content analysis. The obtained findings are presented in Table 5.

Table 5.
Mental Models of the Gifted Middle School Students Depending on the State of Experiencing an Earthquake

Models	State of experiencing an earthquake	
	Yes (n=20)	**No** (n= 21)
Natural disaster-energy-destruction model	1	-
Natural disaster-earth's crust movement-destruction model	3	3
Natural disaster-destruction model	2	-
Energy-protection model	1	-
Quake model	2	2
Quake-destruction model	7	9
Earth's crust movement model	4	1
Earth's crust movement-protection model	1	1
Earth's crust movement-destruction model	3	5

It was determined that the concept of earthquake in the students who experienced an earthquake was explained with nine different mental models. On the other hand, the concept of earthquake in the students who did not experience an earthquake was explained with six different models.

The written and visual descriptions of the 20 students who experienced the earthquake phenomenon were found to be gathered under the models of natural disaster-energy-destruction (f=1), natural disaster-earth's crust movement-destruction (f=3), natural disaster-destruction (f=2), energy-protection (f=1), quake (f=2), quake-destruction (f=7), earth's crust movement (f=4), earth's crust movement-protection (f=1) and earth's crust movement-destruction (f=3). In addition, the visual images of the students in this group include images related to the feeling of fear and the post-earthquake process. Sample student answers are given in Table 6.

Table 6.
The Drawing Produced as A Response to the 3rd Question

Drawing	Student Answers
	*S18 / Experiencing an earthquake / Quake-destruction model* The answer given to the 1st question: "Shaking of the earth" The answer given to the 2nd question: "Cracking of fault lines"

Table 6 continuing

	*S40 / Earth's crust movement-destruction model / Not experiencing an earthquake* The answer given to the 1st question: "Vibration of crusts underground" The answer given to the 2nd question: "Tiles overlap"

On the other hand, the written and visual descriptions of the 21 students who did not experience the earthquake phenomenon were found to be gathered under the models of natural disaster-earth's crust movement-destruction (f=3), quake (f=2), quake-destruction (f=9), earth's crust movement (f=1), earth's crust movement-protection (f=1) and earth's crust movement-destruction (f=5). According to the findings, the students who have earthquake experience have a wider perspective on the mental models of the concept of earthquake.

Findings of the Third Research Question

It was attempted to determine how the mental models of the gifted middle school students on the concept of earthquakes vary depending on their source of earthquake information. The written and visual descriptions of the students were analyzed by using content analysis. The obtained findings are presented in Table 7.

Table 7.
Mental Models of the Gifted Middle School Students Depending on their Source of Information on Earthquake

Source of information on earthquake	Models	f
Family (n=4)	Natural disaster-energy-destruction model	1
	Quake-destruction model	2
	Earth's crust movement-destruction model	1
Internet (n=7)	Natural disaster-earth's crust movement-destruction model	2
	Quake model	1
	Quake-destruction model	3
	Earth's crust movement model	1
Daily experience (n=14)	Natural disaster-earth's crust movement-destruction model	4
	Energy-protection model	1
	Quake model	1
	Quake-destruction model	4
	Earth's crust movement-destruction model	4
School (n=14)	Natural disaster-destruction model	1
	Quake model	1
	Quake-destruction model	6
	Earth's crust movement-protection model	1
	Earth's crust movement-destruction model	3
Book (n=1)	Natural disaster-energy-destruction model	1
Media (n=1)	Quake-destruction model	1

According to the findings, the students obtain information about earthquakes through family, internet, experience, school, books and media, and their mental models are constructed in line with this information.

It was determined that the written and visual descriptions of the 4 students whose source of information is the family are gathered under the models of natural disaster-energy-destruction (f=1), quake-destruction (f=2), earth's crust movement-destruction (f=1) and that the written and visual descriptions of the 7 students whose source of information is the internet are gathered under the mental models of natural disaster-earth's crust movement-destruction (f=2), quake (f=1), quake-destruction (f=3), earth's crust movement-destruction (f=1). The written and visual descriptions of the students whose source of information is their daily experiences were found to be gathered under the mental models of natural disaster-earth's crust movement-destruction (f=4), energy-protection (f=1), quake (f=1), quake-destruction (f=4), earth's crust movement-destruction (f=4). The written and visual descriptions of the 14 students whose source of information is a school were found to be gathered under the mental models of natural disaster-destruction (f=1), quake (f=1), quake-destruction (f=6), earth's crust movement-protection (f=1) and earth's crust movement-destruction (f=3). Moreover, the written and visual descriptions of the students who learn from books about earthquakes were found to be gathered under the mental model of natural disaster-energy-destruction (f=1) while those of the students who learned from media were found to be gathered under the mental model of quake-destruction (f=1). Sample student answers are given in Table 8.

Table 8.
The Drawing Produced as A Response to the 3rd Question

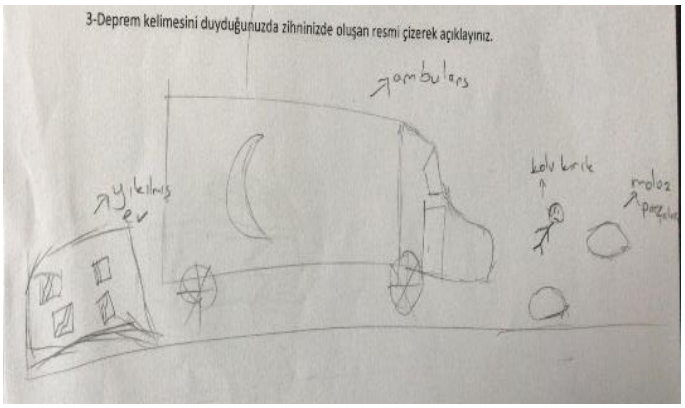
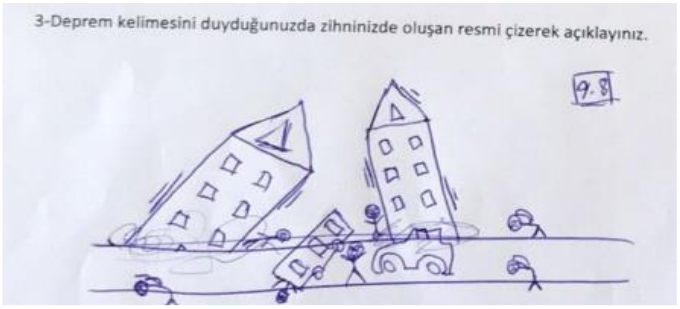
Drawing	**Student Answers**
	*S31 / Internet / Natural disaster-earth's crust movement-destruction* The answer given to the 1st question: "Earth's crust shaking" The answer given to the 2nd question: "Shaking of the ground when the plates in the earth's crust move"
	*S7 / School / Quake-destruction model* The answer given to the 1st question: "Earthquake, shaking off the earth's crust" The answer given to the 2nd question: "Compression of the fault line"

Table 8 continuing



S11/ School / Quake-destruction model

The answer given to the 1st question: "Earthquake"

The answer given to the 2nd question: "Earth's crust moves and an earthquake happens."

Findings of the Fourth Research Question

It was tried to determine how the mental models of the gifted middle school students on the concept of earthquake vary depending on gender. The written and visual descriptions of the students were analyzed by using content analysis. The obtained findings are presented in Table 9.

Table 9.
Mental Models of the Gifted Middle School Students Depending on Gender

Models	**Gender**	
	Girl (n=18)	**Boy** (n= 23)
Natural disaster-energy-destruction model	1	-
Natural disaster-earth's crust movement-destruction model	3	3
Natural disaster-destruction model	2	-
Energy-protection model	1	-
Quake model	2	2
Quake-destruction model	4	12
Earth's crust movement model	1	1
Earth's crust movement-protection model	1	-
Earth's crust movement-destruction model	3	2

The written and visual descriptions of the 18 gifted female students about the concept of earthquake were found to be gathered under the mental models of natural disaster-energy-destruction (f=1), natural disaster-earth's crust movement-destruction (f=3), natural disaster-destruction (f=2), energy-protection (f=1), quake (f=2), quake-destruction (f=4), earth's crust movement (f=1), earth's crust movement-protection (f=1), earth's crust movement-destruction (f=3). On the other hand, the written and visual descriptions of the 23 male students about the concept of earthquake were found to be gathered under the mental models of natural disaster-earth' crust movement-destruction (f=3), quake (f=2), quake-destruction (f=12), earth's crust movement (f=1), earth's crust movement-destruction (f=5).

It was determined that the concept of earthquake was explained with five different mental models by the male students. Accordingly, it is seen that the concept of quake is more emphasized in both the written and visual descriptions of the male students than the others (f=12). However, while the written descriptions contain explanations about the movement of the earth's crust, some descriptions contain images of destruction in the visual images (earth's crust movement-destruction model (f=5)). On the other hand, it was determined that the concept of earthquake was explained with nine different mental models by the female students. Accordingly, while the concept of earthquake was described as a natural disaster, the female students included images indicating the effects of the earth's crust on the formation of earthquake and images of destruction, as well as the quake-destruction model. On the

other hand, different from the male students, there are models related to the ways of protection from earthquakes for female students. Sample student answers are given in Table 10.

Table 10.
The Drawing Produced as A Response to the 4th Question

Drawing	Student Answers
	*S40 / Male/ Earth's crust movement-destruction* The answer given to the 1st question: "Vibration of crusts underground" The answer given to the 2nd question: "Tiles overlap"
	*Ö19 / Female / Earth's crust movement-protection model* The answer given to the 1st question: "Ground shaking" The answer given to the 2nd question: "Frictional movement of broken ground pieces"

Findings of the Fifth Research Question

It was tried to determine how the mental models of the gifted middle school students on the concept of earthquake vary depending on the city where they live. The written and visual descriptions of the students were analyzed by using content analysis. The obtained findings are presented in Table 11.

Table 11.
Mental Models of the Gifted Middle School Students Depending on the City Where They Live

	Cities		
Models	**1st City**	**2nd City**	**3rd City**
Natural disaster-energy-destruction model	-	-	1
Natural disaster-earth' crust movement-destruction model	2	4	-
Natural disaster-destruction model	1	1	-
Energy-protection model	-	-	1
Quake model	1	1	2
Quake-destruction model	4	3	9
Earth's crust movement model	1	-	1
Earth's crust movement-protection model	-	-	1
Earth's crust movement-destruction model	2	2	4

The written and visual descriptions of the gifted middle school students in the 1st city about the concept of earthquake were found to be gathered under the mental models of natural disaster-earth's crust movement-destruction (f=2), natural disaster-destruction (f=1), quake (f=1), quake-destruction (f=4), earth's crust movement (f=1) and earth's crust movement-destruction (f=2); the written and visual descriptions of the gifted middle school students in the 2nd city about the concept of earthquake were found to be gathered under the mental models of natural disaster-earth's crust movement-destruction (f=4), natural disaster-destruction (f=1), quake (f=1), quake-destruction (f=3), earth's crust movement-destruction (f=2) and the written and visual descriptions of the gifted middle school students in the 3rd city were found to be gathered under the mental models of natural disaster-energy-destruction (f=1), energy-protection (f=1), quake (f=2), quake-destruction (f=9), earth's crust movement (f=1), earth's crust movement-protection (f=1), earth's crust movement-destruction (f=4).

Conclusion, Discussion and Suggestions

In this section, the findings obtained in the current study are discussed in light of the results of the existing research in the literature and suggestions are made for researchers and educators who will work in this field in the future.

In the first sub-question of the study, it was aimed to determine the mental models of the gifted middle school students about the concept of earthquake. When the findings were evaluated, it was seen that the gifted middle school students had nine different mental models related to the concept of earthquake. When these mental models are examined, it can be said that "quake-destruction" and "earth's crust movement-destruction" models come to the fore. In the answers of only nine of the students participating in the study, the earthquake was expressed as a natural disaster. This result is consistent with the results of the studies in the literature. Similar results were obtained in the studies conducted by Aydın (2010), Aydın and Çoşkun (2010), Buluş-Kırıkkaya et al. (2011), Savaşçı and Uluduz (2013), Yalman and Yalman (2019). In addition, it was seen that the students often tried to explain earthquakes with the concepts of earth's crust movement, quest and destruction. Similar results were obtained in the studies conducted by Aydın (2010), Aydın and Çoşkun (2010), Demirkaya (2007), Ross and Schull (1990; 1993), Savaşcı and Uluduz (2013), Yalman and Yalman (2019). At this point, it can be said that the definitions, concepts and visuals used by students to describe and visualize the concept of earthquake are insufficient. The reason for this situation can be shown as the fact that students do not have a scientific mental model about the concept of earthquake.

In the second sub-question of the study, it was tried to determine how the mental models of the gifted middle school students about earthquake vary depending on the state of experiencing an earthquake. When the findings were evaluated, it was seen that there were nine different mental models in the students who experienced an earthquake and six different mental models in the students who did not experience an earthquake. In both groups, it can be said that the greatest emphasis was put on the "quake-destruction" model. While only six of the students with earthquake experience described the earthquake as a natural disaster, only three of the students who had no earthquake experience described the earthquake as a natural disaster. When the findings were evaluated, it was seen that some of the students in both groups mentioned the ways of protection during an earthquake in their visuals. However, at this point, it was determined that the students in both groups drew individuals who sought protection by hiding under the table, desk and furniture-like structures during the earthquake. However, if we are inside the building at the time of the earthquake, what we need to do is to create a triangle of life for ourselves by crouching or lying down under a table supported by solid chairs, if any, or next to items that can provide protection, such as a full and bulky armchair, sofa, and a full chest. At this point, it can be said that students in both groups have misunderstandings.

In the third sub-question of the study, it was tried to determine how the mental models of the gifted middle school students on the concept of earthquake vary depending on their source of information about it. When the findings were evaluated, it was seen that the students mentioned daily experience, school, internet, family, books and media as their sources of information about the concept of

earthquake. Cvetkovic et al. (2015) concluded that middle school students' information sources about earthquakes could be listed as television, internet, lessons, video games and radio. It can be said that experience and school came to the fore in the current study. When the mental models of 14 students who pointed to their daily experiences as a source of information were examined, it was seen that five different mental models came to the fore and when the mental models of the students who pointed to school as a source of information were examined, it was again seen that five different mental models came to the fore. It can be said that the most emphasized mental model in both groups is the "quake-destruction" mental model.

In the fourth sub-question of the study, it was tried to determine how the mental models of the gifted middle school students about earthquake vary depending on gender. When the findings were evaluated, nine different mental models were determined for the female students and five different mental models for the male students. It can be said that the model that came to the fore in both groups is the "quake-destruction" model. Unlike the male students, "natural disaster-energy-destruction", "natural disaster-destruction", "energy-protection" and "earth's crust movement-protection" mental models were determined for the female students. This result can be interpreted as women or girls are more affected by earthquakes than men or boys due to their gender roles in society.

In the fifth sub-question of the study, it was tried to determine how the mental models of the gifted middle school students about earthquake vary depending on the city where they live. When the findings are evaluated, it can be said that the "quake-destruction" model is the most common mental model in all the cities. All the cities included in the study are located in the earthquake zone and have recently experienced an earthquake.

When the findings obtained from the research are evaluated in general, it can be said that gifted middle school students do not have an adequate understanding of earthquake. The most common mental model among the students in the current study was the "quake-destruction" model. Individuals can have very different sources of information about earthquakes. However, Tsai, Lin and Tsai (2001) drew attention to the importance of family, television and radio at this point. Especially in our country, the publication of images of collapsed buildings and debris in the news about the earthquake, and the headlines "shaking like a cradle, the shaking continues, we have rocked again, etc" in the news may have been effective in the formation of this mental model about the earthquake in individuals.

In the current study, it was tried to determine the mental models of the gifted middle school students about the earthquake and it was tried to determine how these mental models were affected by variables such as earthquake experience, source of information about earthquake, gender and city of residence. In this study, different variables that may have an effect on mental models about earthquake are discussed. Future studies can be carried out by using different variables such as grade level, economic status of the family and students' ability. In this study, description and visualization questions were included in the data collection tool. Open-ended questions and drawings can contain a lot of data. For this reason, it may be recommended to support data collection tools with interviews in further studies. In addition, the research findings were obtained from three science and art centers in Turkey and are limited to 41 participants. The subject can be studied within larger samples.

Acknowledgment

Ethic statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, that all authors contribute to the study and that all the responsibility belongs to the article authors in case of all ethical violations.

Author Contributions: Conceptualization, Kaymakcı, G. and Çelik, G.; methodology, Kaymakcı, G., Görecek-Baybars, M.; validation, Kaymakcı, G., Çelik, C. and Görecek- Baybars, M.; analysis, Görecek- Baybars, M. ;

writing, review and editing, Kaymakcı, G., Çelik, C. and Görecek- Baybars, M.; supervision, Kaymakcı, G. Çelik, C. ; project administration, Kaymakcı, G., Çelik, C. and Görecek- Baybars, M.

Funding: This research received no funding.

Institutional Review Board Statement: Permissions were taken with the final decision of Tokat Gaziosmanpaşa University Social and Human Sciences Research Ethics Committee's meeting dated 27/04/2022, the session number is 07 and the decision number is 01-62.

Data Availability Statement: Data generated or analysed during this study should be available from the authors on request.

Conflict of Interest: There is no conflict of interest among authors.

References

AFAD (2022). *Doğal Afetler.* Afet ve Acil Durum Yönetim Başkanlığı. https://www.afad.gov.tr/afadem/dogal-afetler.

AFAD. (2018). *Türkiye'de afet yönetimi ve doğal kaynaklı afet istatistikleri*. Afet ve Acil Durum Yönetimi Başkanlığı.

Akarsu, F. (2004b). Üstün yetenekliler. Şirin M. R., Kulaksızoğlu A., Bilgili A. E. (Ed.). Üstün yetenekli çocuklar seçilmiş makaleler kitabı, İstanbul: Çocuk Vakfı Yayınları, 127–154.

Akbaba, B., Kılcan, B. & Çepni, O. (2013). The effect of 2011 Van earthquake on 8th grade students' value rankings. *Mevlana International Journal of Education, 3*(4), 75-85.

Akyel, R. (2000). *Gölyaka'da Deprem*. İstanbul: Gren Ajans.

Aydın, F. (2010). İlköğretim sekizinci sınıf öğrencilerinin deprem kavramını algılamaları: Fenomenografik bir analiz. *Turkish Studies, 5*(3), 801-817.

Aydın, F., & Coşkun, M. (2010). Observation of the students' "earthquake" perceptions by means of phenomenographic analysis (primary education 7th grade –Turkey). *International Journal of the Physical Sciences. 5*(8), 1324- 1330.

Babüroğlu, S. (1998). *Deprem ve Devlet*. Ankara: TBMM Vakıf Ofset Tesisi.

Başıbüyük, A. (2004). Yetişkinlerde deprem bilgisi ve etkili faktörlerin incelenmesi. *Milli Eğitim Dergisi, 161,* 205- 218.

Buluş-Kırıkkaya, E., Bozkurt, E., İşeri, Ş., Vurkaya, G., & Bali, G. (2011). TÜBİTAK supported science summer school for primary school students: happinence of learning by exploring and enjoying. *Procedia Social and Behavioral Sciences, 15,* 2219–2227.

Camcı, S. (2011). Üstün zekâlı ve yeteneklilerde cinsiyet farklılığı. *Hasan Ali Yücel Eğitim Fakültesi Dergisi, 16*(2), 105-117.

Chia-yu, W. (2007). *The Role of mental-modeling ability, content knowledge, and mental models in general chemistry students' understanding about molecular polarity* [Unpublished doctoral dissertation]. University of Missouri, Columbia.

Cvetković, V., Ivanov, A., & Sadiyeh, A. (2015, March 3-4). *Knowledge and perceptions of students of the Academy of criminalistic and police studies about natural disasters*. [Conference presentation abstract]. The International Scientific Conference Archibald Reiss Days, Belgrade, Serbia.

Çağlar, D. (2004). Üst*ün Zekalı Çocukların Özellikleri. Üstün Yetenekli Çocuklar Seçilmiş Makaleler Kitabı,* İstanbul: Çocuk Vakfı Yayınları.

Demirci, A., & Yıldırım, S. (2015). The evaluation of the earthquake awareness of the secondary school students in Istanbul, *National Education*, 207, 89-117.

Demirkaya, H. (2007). İlköğretim Öğrencilerinin Deprem Kavramı Algılamaları ve Depreme İlişkin Görüşleri. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergi*si, *8,* 68-76.

Franco, C. & Colinvaux, D. (2000). *Grasping mental models.* John K. Gilbert, Carolyn J. Boulter (Ed.). Developing Models İn Science Education. Springer, Dordrecht. https://doi.org/10.1007/978-94-010-0876-1_5.

Günbatar, S., & Sarı, M. (2005). Developing models for difficult and abstract concepts in electrics and magnetism. *Gazi University Gazi Faculty of Education Journal, 25*(1), 185-197.

International Decade for Natural Disaster Reduction. (1992). Internationally agreed glossary of basic terms related to disaster manegement. Geneva: United Nations Department of Humanitarian Affairs (UNDHA). Retrived from https://reliefweb.int/sites/reliefweb.int/files/resources/004DFD3E15B69A67C1256C4C006225C2-dha-glossary-1992.pdf

İyibil, Ü. & Sağlam Arslan, A. (2010). Pre-service physics teachers' mental models about stars. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 4*(2), 25-4.

Kadıoğlu, M. (2011). *Afet Yönetimi Beklenilmeyeni Beklemek En Kötüsünü Yönetmek* (2. edition). T.C. Marmara Belediyeler Birliği Yayınları.

Kasapoğlu, A. & Ecevit, M. (2001). *Depremin Sosyolojik Araştırması*. Ankara: Sosyoloji Derneği Yayınları.

Miles, M, B. & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Ministry of National Education (MoNE) (2013a). İlköğretim Fen ve Teknoloji dersi (4-8.sınıflar) öğretim programı. Ankara: T.C. Milli Eğitim Bakanlığı Talim Terbiye Kurulu Başkanlığı.

Ministry of National Education (MoNE) (2013b). İlköğretim Sosyal Bilgiler dersi (4-7. sınıflar) öğretim programı. Ankara: T.C. Milli Eğitim Bakanlığı Talim Terbiye Kurulu Başkanlığı.

Navakanesh, B., Shah, A. & Prasanna, M. V. (2019). Earthquake education through the use ofdocumentary movies. *Frontiers in Earth Science, 7*(42), 1-16.

Oğuz, A. (2005). *Surveying American and Turkish middle school students' existing knowledge of earthquakes by using a systemic network* [Unpublished doctoral dissertation]. Ohio State University.

Ross, K. & Schuell. T. (1993). Children's beliefs about earthquakes. *Science Education, 77*(2), 191-205.

Savasci, F. & Uludüz, H. (2013). Fifth grade elementary students' conceptions of earthquakes. *Asia-Pacific Forum on Science Learning and Teaching, 4*(2), 118.

TMMOB. (2012). Türkiye'de deprem gerçeği ve TMMOB Makina Mühendisleri Odası'nın önerileri oda raporu. Ankara: TMMOB Yayınları.

Tsai, C., Lin, S. & Tsai, M. (2001). Developing an Internet attitude scale for high school students. *Computers and Education, 37,* 41–51.

Turan, İ. & Kartal, A. (2011, Eylül). *İlköğretimde doğal afetler öğretiminin öğretmen görüşlerine göre değerlendirilmesi*. [Conference presentation abstract]. 20. Ulusal Eğitim Bilimleri Kurultayı. Burdur, Türkiye.

Turan, İ. & Kartal, A. (2012). İlköğretim 5. Sınıf Öğrencilerinin Doğal Afetler Konusu ile İlgili Kavram Yanılgıları. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD), 13*(3), 67-81.

Ünal, G., & Ergin, Ö. (2006). Fen eğitimi ve modeller. *Milli Eğitim, 35*(171), 188-196.

Watt, F. (2002). Depremler ve Yanardağlar. (Translated by: Deniz Yurtören), (18th Edition). Ankara: TÜBİTAK Popüler Bilim Kitapları.

Yalman, N. & Yalman, Y. (2019). Deprem eğitiminin İstanbul'da ortaöğretim öğrencilerinin deprem bilincinin arttırılmasına etkisi. *Atlas International Refereed Journal on Social Sciences, 5*(17), 140-155.

Yıldırım, A. & Şimşek, H. (2006). *Sosyal bilimlerde nitel araştırma yöntemleri* (6th Edition). Seçkin Yayıncılık.