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Metaphorical Perceptions of Gifted Students towards Mathematics and Science Concepts

Duygu Özdemir **Ayşegül Kınık Topalsan**

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CORRESPONDENCE
Duygu Özdemir
duyguozdemir5@aydin.edu.tr
Istanbul Aydin University, Turkey.

AUTHORS DETAILS
Additional information about the authors is available at the end of the article.

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ABSTRACT

Background/purpose – Understanding gifted students' perceptions by means of metaphors, carefully examining and interpreting them may help to guide the organization of training programs and the differentiation of educational content for gifted students. This study aims to reveal the perceptions of gifted students regarding science and mathematics concepts as well school math, school science, scientist, experiments, and problem-solving perceptions by examining students' metaphors.

Materials/methods – 30 gifted students studying at a children's university, which was established by a foundation university in Istanbul, Turkey, were selected as the study's participants based on convenience, criterion, and accessibility sampling methods. To reveal the students' metaphorical perceptions, gifted students were asked about their metaphors for "mathematics," "science," "mathematics lessons at school," and "science lessons at school." Data were collected using a Metaphorical Perception Form, and then transferred to the QDA Mine Lite program for qualitative data analysis, which included coding and the creation of categories and themes.

Results –Metaphors about mathematics, Metaphors about school mathematics, Metaphors about science, and Metaphors about school science were obtained as the themes of the study.

Conclusion – In a general sense, three categories of findings were obtained across all four themes. For metaphors about mathematics, the categories were "favorable," "relating," and "difficulty level"; whilst for school mathematics they were "favorable," "relating," and "unfavorable"; for science they were "favorable," "relating," and "difficulty level"; and for school science they were "favorable," "relating," and "unfavorable."

Keywords – Gifted students, mathematics, metaphor, science

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1. INTRODUCTION

Studies about metaphor, which is effectively describing something unknown by referring to something known, have attracted attention in recent years for both their application in teaching and as a means of providing a deeper understanding of students' perceptions. Since metaphors can be thought of as means to evaluate the cognitive understanding of students' perception of concepts through their resemblances with well-known concepts (Kövecses, 2002), the investigation of students' metaphorical perceptions can be applied in order to reveal the roles of teachers in the classroom, teachers' or students' beliefs, as well as feelings, thoughts and assumptions about certain concepts or education (Ben-Peretz et al., 2003; Di Paola et al., 2020; Thomson & Holland, 2015). Additionally, metaphors allow us to better understand a person's perception of a concept related to an experience or idea; hence, metaphors are widely used in the field of education (Massengill et al., 2005). Arslan and Bayrakçı (2006) defined metaphors as mind mapping for people to make sense of and construct their own world. From that perspective, they can be expressed as a powerful pedagogical tool that can be applied so as to reveal, understand, and adapt mental images that individuals have or create regarding certain phenomena (Saban, 2008).

Metaphor studies are considered important in terms of diversifying the definitions of learning concepts, which differ as learning needs change over time. For example, Wegner and Nückles (2015a) asked 91 students about learning metaphors and evaluated their learning strategies, epistemological beliefs, and motivation to study. It was revealed that those students with personal growth metaphors had stronger intrinsic motivation, greater use of higher-order thinking skills, and a stronger awareness about the temporal nature of knowledge. Löfström and Poom-Valickis (2013) conducted a study that evaluated students' learning metaphors and teachers' roles, and it was seen that learning metaphors created by the learners had a relation to the roles of their teachers in the classroom. Wegner et al. (2020) then examined whether or not metaphors created by 129 high school students and 59 university students could be associated with their learning approaches. Two types of metaphors were identified, as learning-oriented metaphors that concentrated on learning processes and outcomes, and self-referential metaphors that considered the motivational aspects of learning.

The most common approach of using metaphors in educational science is to verbally capture the metaphors used by participants (Martinez et al., 2001), or in writing (Seung et al., 2015), as drawings (Lehner, 2016), or even through photography (Hamilton, 2016). While producing these metaphors, individuals reveal their inner thoughts, and the cognitive process that develops them creates an effect in the individual. That is, the interaction of cognitive and affective processes leads individuals to use certain metaphors when describing their inner feelings and thoughts, or the feelings and thoughts of others. In this context, metaphors show the way in which individuals perceive the world around them, and also themselves (Girmen, 2007) and thus, metaphors can help guide teachers to employ the most appropriate teaching processes (Musolff & Zinken, 2009). Moreover, in order to reveal students' beliefs about themselves as learners, their perceptions of learning environments, their study orientation preferences, motivations, and learning strategies, it is necessary to reveal the mental models that students have (Richardson, 2011). Hence, metaphors present numerous advantages for both educators and learners (Sternberg, 2008).

2. LITERATURE REVIEW

Metaphors in Science and Mathematics Education

Gibbs (2014) argued that using metaphors can potentially affect our perspective on certain issues and they may even help us to understand how certain researched meanings are perceived (Cerit, 2008; Rızvanoğlu, 2007). That is, they can be seen as an important tool in determining students' perceptions regarding different concepts such as students' beliefs about a particular learning process (Wegner & Nückles, 2015a, 2015b), or the teaching of science and mathematics (Noyes, 2006). Thus, in addition to studies published regarding metaphors concerning teaching and learning in general, metaphors that students create and encounter can also significantly relate to how they think about mathematics and science (Olsen et al., 2020).

In Turkey, especially since the 2000s, research has been published in which metaphor studies are frequently conducted in order to determine the perceptions of participants towards a specific subject or concept, such as science or mathematics, for example. For instance, Derman (2014) attempted to reveal high school students' perceptions about chemistry concepts through metaphors, and the study provided indications about students' perspectives both on chemistry as well as their attitudes towards chemistry. Furthermore, in a study conducted by Anilan (2018), it was seen that preservice science teachers who produced positive metaphors for the concept of chemistry had a more positive attitude towards the lesson. Additionally, Aktamış and Dönmez (2016) aimed to reveal the perceptions of middle school (grades 5-8) students about the concepts of "science lesson," "science teacher," "science," and "scientist" through metaphors, and the results revealed how strong the imagination and analogy abilities of the students at this grade level were. Furthermore, Minas and Gündoğdu (2013) revealed the perceptions of primary school students regarding the unit concepts of "electricity in our lives" and the "structure and properties of matter" through the use of metaphors, which were revealed to mostly relate to their conceptual understanding. Moreover, Thomas and McRobbie (2013) conducted an interpretive study that investigated students' metaphors in an 11th-grade chemistry class. The students' metaphors were found to be compatible with their views about learning and learning processes, as evidenced through multiple data sources. They also stated that metaphors provide a versatile flow of information which encourages students' learning processes towards research, development, and metacognition.

In addition to studies concentrating on science education issues, metaphor studies related to mathematical concepts are also notable. For example, Çetinkaya et al. (2018) conducted a study with secondary school students that revealed four themes regarding their perceptions about mathematics; namely, content of mathematics, applicability of mathematics, mathematics, and the teaching of mathematics. Moreover, the perceptions of primary school fourth-grade students about mathematics lessons were attempted to be revealed using metaphors by Çekirdekci (2020), which were found to be mostly categorized as affective features for mathematics as mathematics knowledge, principles of mathematics teaching, mathematical skills, and affective characteristics for mathematics. Moreover, Idin and Donmez (2017) attempted to determine which metaphors seventh- and eighth-grade students used to identify STEM subjects. The students used the technology metaphor 11 times when describing science, and the science metaphor five times when describing the technology. However, it was clear from the metaphors used that the students lacked knowledge about mathematics and engineering since the metaphors used were unable to adequately explain these subjects. In another study, Köse (2018) examined the effect of secondary school students' metaphorical perceptions of mathematics lessons and teachers on success. The positive and negative metaphors that the students produced for mathematics lessons and mathematics teachers were compared with those for mathematics achievement. The students' metaphorical perceptions of mathematics lessons and mathematics teachers were found to be parallel, whilst it was determined that positive or negative attitudes towards lessons and teachers may directly affect the students' success.

Metaphors in Science Concepts

The language of science is largely metaphorical, with scientists relying upon metaphor and analogy to make sense of scientific phenomena, and also to communicate their findings; both amongst themselves and to the wider public (Taylor & Dewsbury, 2018). Notable scientists in history such as Darwin and Einstein believed that the use of metaphors was vital to the development of scientific ideas (Montuschi, 2017). While the language of everyday science facilitates the precise formulation and testing of scientific ideas, it is not particularly conducive to the creation and understanding of new ideas. As humans, we need language that allows for human intuition (Yanai & Lercher, 2020). At this point, metaphors developed by students can help to guide us.

The literature contains numerous studies that reveal metaphoric perceptions about the concepts of science and scientist. Şenel and Aslan (2014) conducted a study with teacher candidates in which it was observed that preservice teachers' perceptions of science and scientist were positive, but that they held unrealistic and traditional perceptions for both of these concepts. Aktamış and Dönmez (2016) revealed the mental images of secondary school students (grades 5-8) regarding the concepts of science and scientist through metaphors. When the metaphors regarding the concept of scientist were analyzed, it was determined that they viewed scientists mostly as researchers, questioners, striving persons, and beneficial providers. Kalaycı (2018) conducted a similar study with primary school students in which metaphors about the concept of science were examined. When the metaphors the students created about science were examined, it was observed that they mostly drew attention to the information, technology, intelligence, experiment, and research aspects of science.

In other studies, Bartan (2019) aimed to determine the metaphorical perceptions of preschool teacher candidates regarding both the characteristics and concepts of scientists. When the images of scientists in the minds of the preschool teachers were examined (bee, astronaut, empty box, kid, detective, etc.), it was seen that they viewed scientists as researchers, according to the metaphors they used. Sadoglu and Durukan (2018) determined the perceptions of preservice teachers in their research using metaphors regarding the concepts of science lesson, science laboratory, science teacher, and science student. The results of their research showed that most of the preservice teachers viewed the concept of science lesson as understanding/exploring life, the concept of science laboratory as a place that provides life, the concept of science teacher as a mentor, and the concept of science student as a valuable asset.

However, much of the leading work on metaphors in science is still unknown to many scientists who could benefit from the interdisciplinary insights this area of the literature offers (Taylor & Dewsbury, 2018). It is therefore crucial for scientists, science communicators, and science educators to acknowledge the conceptual, social, and political dimensions of science and metaphors in science. In particular, structuring the theories to be produced using metaphors can be deemed beneficial.

Metaphors in Gifted Education

Today, identifying and educating gifted students in various areas such as mathematics, science, and the arts has become a pertinent topic of educational research (Koshy et al., 2009). As such, understanding metaphors may also be considered as a guide in terms of revealing the expectations of gifted students. As known, gifted children exhibit extreme mental stimulation, rapid learning and cascading of complex information, in-depth exploration of issues they are dealing with, and are constantly questioning and examining (Baykoç, 2014). However, they seek certainty in their thinking and expression, a desire to work on single subjects over a long period of time, to work independently, acting in line with their own interests and curiosity, establishing relationships with those older than themselves, and to study under individualized programs of education. At the same time, it is important for gifted children to have their special abilities approved of and supported, to be mentally challenged, to be able to satisfy their own curiosity, and to put their imagination and creativity into practice (Alelyani, 2020). Talented students who are superior in at least one feature compared to their peers, in terms of mental abilities (Bilgiç & Ataman, 2019), can exhibit many skills such as the ability for fast and deep learning, high levels of self-motivation, and advanced critical thinking (Tardif & Sternberg, 1988). In order to address these needs, gifted children need to be provided with adequate opportunity to demonstrate and develop their interests and talents, to work within flexible and creative organizations, and to work in classroom environments that invite and encourage them to participate fully (Heinze, 2005; Koshy, 2002).

Today, many gifted students have yet to realize their full potential, despite the extraordinary cognitive abilities that characterizes them (Siegle & McCoach, 2018; Worrell et al., 2019). More precisely, gifted students can sometimes conceal their potential, especially in the fields of science and mathematics, because they may not receive sufficient guidance from their teachers to feel adequately supported according to their competence needs (Hornstra et al., 2020). In addition, the underlying reason for the failure of some gifted students may be a simple lack of motivation (Preckel et al., 2006; Snyder & Linnenbrink-Garcia, 2013) and thus, researchers have suggested that gifted children constantly require special and adaptive educational programs that target and allow for the variable nature of their giftedness (Fonseca, 2011; Sisk, 2009). In line with this, studies conducted in educational settings have shown that positive relationships exist between supportive instruction for gifted students, their motivation, and school engagement (Stroet et al., 2015).

To summarize, significant changes can be achieved in special education by focusing on the strengths of the individual (Dovigo, 2020) and thus, it is important to recognize and train creative individuals with special needs and to support creativity in the field of special education. Since gifted students who express an interest in mathematics and science often solve problems by questioning, they are among the closest candidates to become our scientists of the future (Johnsen, 2004). Therefore, revealing the perceptions of gifted students with regards to science and mathematics and how they perceive these discipline areas in their mind, and then interpreting these results through careful examination, and ultimately diversifying educational environments according to these perceptual structures may help to optimize the potential for benefit. If studies on the metaphorical perception of gifted students regarding science and mathematics concepts are examined, the needs of gifted students in these disciplines may be much better understood. Although there have not been many studies yet published, some in the current literature have reflected on the importance and needs of revealing and examining gifted students' metaphors. For instance, Arikan and Unal (2015) found in their study with gifted primary and secondary school students, that as the age of the students increased, they produced metaphors for the content of the functionality of mathematics. Öztürk et al. (2014) found that gifted students were able to explain the concept of mathematics mostly through metaphors of the universe, and as their grade level increased, they tended to deal with the nature of mathematics rather than perceiving it as a human need.

Significance of the study

As can be clearly seen from the statements made in the aforementioned studies, gifted students face certain difficulties during their academic life, and factors such as their high cognitive capacity, feeling different in peer relations, and needing extracurricular activities within a different structured educational environment can be shown as reasons for some of the difficulties they face. It is only possible for gifted students to realize their true potential and to contribute both to their own lives and society itself through appropriately designed programs of education. Thus, it is of significant importance to develop programs that are aimed at what gifted students actually need, and to organize their content by considering their basic needs.

Curriculum reforms that aim to accommodate the expectations, perceptions, and needs of gifted students are vital for the development of Turkey's future science and technology sector. From this perspective, revealing the perceptions of gifted students with regards to science and mathematics concepts, carefully examining and interpreting the results, and diversifying educational environments according to these perceptual structures may help to increase gifted students' interest in their education. Therefore, metaphors may be used as a tool to reveal the cognitive and affective perceptions of gifted students, and thereby to help make sense of the points at where gifted students differ from their non-gifted peers (Tan et al., 2013). Revealing the metaphors of gifted students may help guide the design and organization of training programs in which content is differentiated based on the giftedness of students.

In addition, gifted students may possess certain skills and interests, but their experiences within their current school environment may not always show parallelism with their particular skills and attitudes. For this reason, it is important to examine both the metaphors of gifted students about mathematics and science, as well as their metaphorical perceptions of school-based mathematics and science lessons. Considering all of these facts, the current study aims to reveal the perceptions of gifted students about science and mathematics concepts as well their school mathematics and school science perceptions by means of the metaphors they prefer to use. Based on this aim, the following research questions have guided the study:

- What are the metaphorical perceptions of gifted students towards mathematics?
- What are the metaphorical perceptions of gifted students towards science?
- What are the metaphorical perceptions of gifted students towards mathematics lessons at school?
- What are the metaphorical perceptions of gifted students towards science lessons at school?)

3. METHODOLOGY

Participants

The study group of the research consisted of 30 students enrolled at a children's university, which was established by a foundation university in Istanbul, Turkey, and offers education only to gifted students. While determining the study group, criteria, and easily accessible sampling were employed in selecting students from the 2021-2022 academic year. In criterion sampling, all cases that meet a predetermined set of criteria established by the researchers or a previously prepared criteria list can be used in the selection of a study group (Marshall & Rossman, 2014). For the current research, the students' giftedness and attendance at the children's university were determined as the criterion. Moreover, since the researchers work as faculty members at the foundation university within which the children's university is located, ease of access was also taken into consideration in the sampling. Frequencies and percentages of the demographic characteristics of the students that participated in the research are presented in Table 1.

Table 1. Participants' demographic data

Gender	Age range (years)	Frequency
Male	7-9	9 students
	10-12	5 students
Female	7-9	9 students
	10-12	7 students

Data Collection and Analysis Process

Based on the aim of the study, and following receiving the approval of both the university's ethics committee and that of the students' parents, the data collection processes of the study were handled in a classroom environment where the participant gifted students were able to feel relaxed and comfortable. In order to share their thoughts, the gifted students were asked to create metaphors regarding "mathematics," "science," "mathematics lessons at their schools," and "science lessons at their schools." In order to better understand the gifted students' perceptions by means of the metaphors they used, they were also asked to explain the reasons behind the metaphors they chose. Therefore, the aim was to reveal the students' metaphorical perceptions through the widely used "…is like… because..." format using a Metaphorical Perception Form. The form's statements were as follows;

"Mathematics is like _______ because _______."

"Science is like _______ because _______."

"Mathematics lessons at my school are like _______ because _______."

"Science lessons at my school are like _______ because _______."

Qualitative data analysis allows for in-depth data collection and analysis in order to reveal the emotions, thoughts, perceptions, attitudes, and experiences of a study's participants (Creswell, 1999). For this reason, the data collected by means of the Metaphorical Perception Form was then transferred to the QDA Mine Lite program for the qualitative data to be analyzed. Utilizing the functions of the program, the steps of coding, and the creating of categories and themes were completed as is routine in qualitative data analysis (Miles & Huberman, 1994). Each of the students' metaphors and their accompanying explanations made regarding the reasons they chose each metaphor were examined in detail. After completing the assignment of codes for the collected student data, similar codes were gathered together under themes. In this context, each metaphorical perception title was handled separately, and themes related to the metaphorical perceptions of the gifted students were created under the titles of “Metaphors about mathematics,” “Metaphors about school mathematics,” “Metaphors about science,” and “Metaphors about school science.” The findings presented in the following section are arranged under a separate subheading for each theme.

4. RESULTS

Metaphors about Mathematics

Findings from the students’ data reflected that the metaphorical perceptions of gifted students regarding mathematics can be considered under three categories; as metaphors reflecting favorable opinions about mathematics, metaphors mentioning the difficulty level of mathematics, and metaphors interrelating mathematics to other disciplines or issues. Thus, the categories of the findings regarding Metaphors about mathematics were “favorable,” “difficulty level,” and “relating,” as can be seen illustrated in Figure 1.

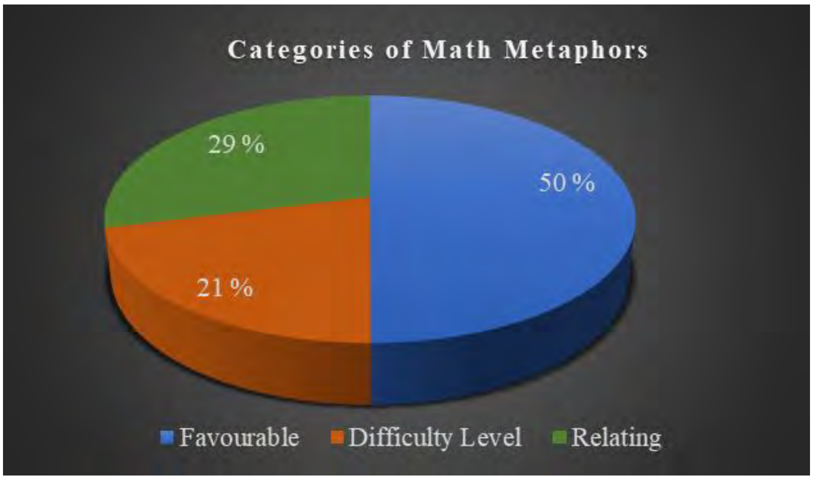

Figure 1. Categories of metaphors about mathematics

When the students’ metaphors related to mathematics (see Table 2) were examined in detail, it can be seen that 50.0% used metaphors reflecting their favorable experiences as their most preferred metaphors, while others preferred to use metaphors concentrating on difficulty level (21.0%) or the interrelations of mathematics (29.0%). Details and phrases that the students in these categories are presented as follows.

Favorable Metaphors

Metaphors in the favorable category are where the gifted students described mathematics with metaphors reflecting their favorable opinions or experiences regarding mathematics such as fun, like, life, and contribution-mind side of mathematics. As can be seen in Table 2, the most used code in this category was “fun” (34.2%), hence it could be said that the metaphorical perceptions of gifted students mostly focused on the fun aspect of mathematics. The following illustrate the metaphorical perceptions of those students who made analogies about the fun side of mathematics:

Mathematics is like playing a game because it gives me energy and happiness.

Mathematics is like a toy because I find it very funny.

Mathematics is like a maze because when you take a wrong path, you need to try again and again to reach the right path, and this can be exciting and fun.

In addition, the students' metaphors that indicated their like or love for mathematics were coded as "like" in the favorable category. The following are examples from the students' statements coded as like for mathematics:

Mathematics is like my favorite because I like it very much.

Mathematics is like what I'm a fan of because I love it.

Three of the students' metaphors reflected positive perceptions about mathematics and which were coded as "contribution-mind," whereby they mentioned the contribution that mathematics made to them, to their minds, intelligence, or learning. For instance:

Mathematics is like intelligence because it strengthens our brain.

Mathematics is like a precious stone because I learn so much from it.

Mathematics is like happiness because I learn while solving math operations.

Metaphors Indicating Difficulty Level

The students' data also reflected describing their perception of mathematics, with eight (21.1%) having used metaphors that mentioned the difficulty level of mathematics, and that they perceived mathematics as a degree of difficulty. Overall, 13.2% of the gifted students stated that mathematics was perceived as being difficult work for them. The following are examples from the students' statements indicating the difficulty of mathematics in their metaphors:

Mathematics is like a runway because it is so hard to reach.

Mathematics is like an exam because it is very difficult.

Mathematics is like tennis because it is hard.

On the other hand, the findings reflected that three of the students' metaphors considered the ease of mathematics. That is, it was seen that some of the students used metaphors stating that mathematics was easy. The following illustrate these metaphorical perceptions in their own words:

Mathematics is like easiness because operations are so simple.

Mathematics is like a riddle because it's easy.

Relating Metaphors

In addition to the metaphors used that indicated positive thoughts or the perceived difficulty level of mathematics, it was also observed that some of the students directly associated certain concepts to mathematics or overstated its relevance. However, whilst preferring such metaphors, the students mentioned neither positive or negative feelings in these associations. Since they failed to clearly state nor provide well-defined reasons in expressing the favorability or unfavorability of the chosen metaphors, the students' metaphorical perceptions are discussed under the separate category of "relating metaphors."

Some of the participant gifted students (13.2%) stated that mathematics forms part of life, or was associated with their real, daily lives, and therefore these metaphorical perceptions were assigned the "life" code. It was then deduced that for some gifted students, math means life and they perceived this aspect of mathematics as a relating feature. Some examples of students having expressed this view metaphorically are as follows:

> *Mathematics is like the meaning of life because it is needed everywhere.*
>
> *Mathematics is like life because it's everywhere in life.*
>
> *Mathematics is like our daily life because mathematics is always used in life.*
>
> *Mathematics is like everything because without mathematics we cannot grasp the logic of things in life.*

Additionally within this category, while three of the students associated mathematics with problems, one referred to mathematics as science, whilst another stated seeing mathematics as music because it was considered to be like a puzzle. These associations based on the students' own expressions can be seen in the following examples:

> *Mathematics is like a problem because it has numbers in it.*
>
> *Mathematics is like a problem because there are so many operations in it.*
>
> *Mathematics is like science because math is similar to science.*
>
> *Mathematics is like music because it sounds like a puzzle to me.*

To summarize this first section of the findings regarding metaphors preferred by the students about mathematics were categorized as positive opinions held about mathematics, its level of difficulty, and the relating of mathematics with various concepts. The findings regarding these categories, codes, frequencies, and percentages are summarized in Table 2.

Table 2. Metaphors regarding mathematics

Category	Code	Frequency	Code %
Favorable	Fun	13	34.2%
	Like	3	7.9%
	Contribution-Mind	3	7.9%
Difficulty Level	Difficult	5	13.2%
	Easy	3	7.9%
Relating	Life	5	13.2%
	Problem	3	7.9%
	Science	2	5.3%
	Other	1	2.6%

Metaphors about School Mathematics

Findings based on the students' data reflected that, while describing their perception about school mathematics lessons, they preferred metaphors that could be categorized as favorable, unfavorable, or relating to other concepts. As can be seen from Figure 2, the metaphors most frequently used were related to favorable experiences or opinions held about mathematics lessons. However, 30% of the students used metaphors reflecting to their unfavorable perceptions about school mathematics. Additionally, two of the students preferred the use of metaphors that related school mathematics to life, and whose statements were categorized as "relating" metaphors. Details about the categories assigned for metaphors relating to school mathematics and some of the students' statements exemplifying the categories are presented under the following subheadings.

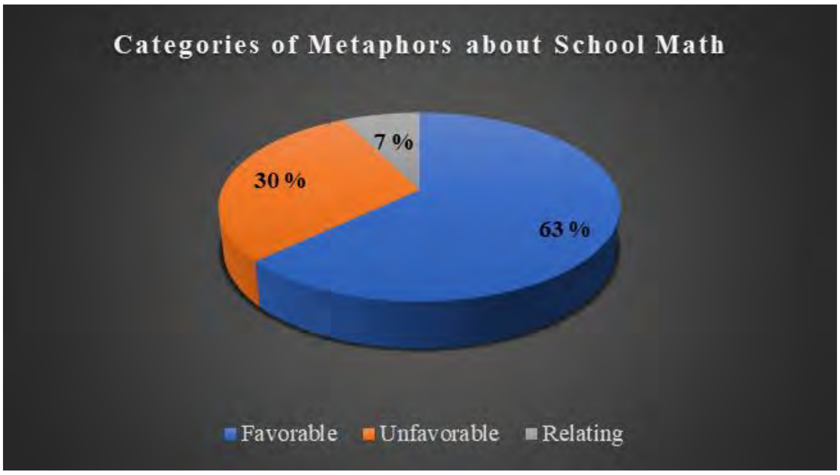

Figure 2. Categories of metaphors about school math

Favorable Metaphors

The findings reflected that the metaphors most frequently used by the gifted students were found to be favorable. In this category, the students mentioned their sense of fun and their liking of school mathematics. The following metaphors reflect some of the excitement and fun reported by the study's participant gifted students:

> *Mathematics lessons at my school are like physical education because it involves lots of fun.*

> *Mathematics lessons at my school are like excitement because I get very excited about entering the lessons.*

> *Mathematics lessons at my school are like playing in a match because it is enjoyable.*

> *Mathematics lessons at my school are like a race because we get excited.*

Also in the category of favorable metaphors, seven of the students mentioned their love of math, as exemplified by the following metaphors:

> *Mathematics lessons at my school are like a book because I love them.*

> *Mathematics lessons at my school are like a beautiful feeling about something because I like them.*

Unfavorable Metaphors

As previously stated, a second category based on unfavorable metaphors emerged from the gifted students' metaphors related to school mathematics. In this category, eight of the students (29.6%) preferred metaphors that indicated an unfavorable opinion or experience related to school mathematics lessons. Examples of these metaphors are presented as follows:

Mathematics lessons at my school are like zombies because you have to hide from them.

Mathematics lessons at my school are like placing books on our tables for 2 hours because it is the only activity we do.

In addition to the general expression of dissatisfaction, it was observed that the students frequently talked about the boringness of mathematics at school, and can be exemplified as follows:

Mathematics lessons at my school are like tasteless because they are very boring.

Mathematics lessons at my school are like any boring activity because they are very easy.

Mathematics lessons at my school are like a bad thing because they are boring and unpleasant.

Lastly in this category, one of the students stated the reason for their negative perception of mathematics at school as being due to the way in which teachers conduct their lessons, and also the perceived easiness of the content.

Mathematics lessons at my school are like tedious because the teacher cannot explain it that well and chooses easy things to do in the lessons.

Relating Metaphors

As the final category for the students' metaphors about school mathematics, the relating category emerged according to two of the students' statements. In their metaphors, the students mentioned school mathematics as being related to life.

Mathematics lessons at my school are like art or an important mission because everything is math.

Mathematics lessons at my school are like all lessons because math is everywhere in life, even in physical education lessons (as numbers are often used).

To summarize, the findings obtained from the gifted students' data about metaphors related to school mathematics were grouped into three categories, as students' favorable and unfavorable metaphorical perceptions, as well as their ideas about the relationship of mathematics with real life. The categories, codes, frequencies, and percentages are presented in Table 3.

Table 3. Metaphors regarding school mathematics

Category	Code	Frequency	Code %
Favorable	Fun	10	37.0%
	Liking	7	25.9%
Unfavorable	Boring	8	29.6%
Relating	Life	2	7.4%

Metaphors about Science

In addition to the gifted students' metaphors about mathematics and school mathematics, metaphors about science (and in the next section, school science) were also analyzed. Based on the data obtained through this process, it can be seen that the metaphors selected to describe the students' experiences or views about science were grouped under three categories. That is, the gifted students' metaphors about science indicate favorable views, metaphors that associate science with certain concepts, or about the perceived difficulty level of science. As can be seen in Figure 3, categories obtained from the students' science metaphors were favorable (49.0%), relating (48.0%), and difficulty level (3.0%). Under the following subheadings, details regarding each category are presented, along with example metaphorical phrases.

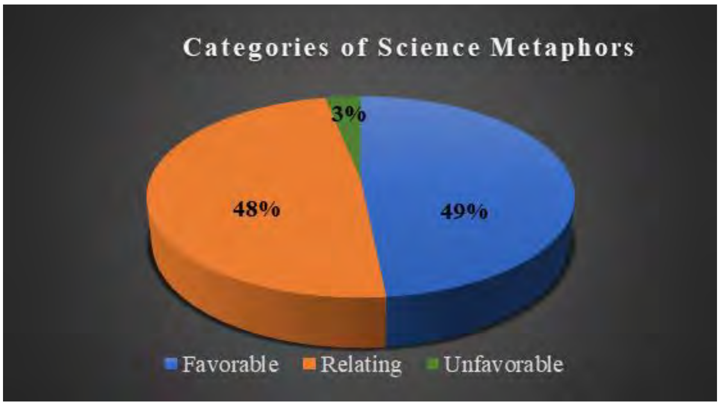

Figure 3. Categories of metaphors about science

Favorable Metaphors

As can be clearly seen from Figure 3, two categories of metaphor were close in terms of which was most frequently used by the gifted students in their perceptions of science, but discourses reflecting the students' positive perceptions of science was slightly ahead. In addition, the findings showed that metaphors considered in the favorable category tended to focus on the fun, enjoyment, as well as students' love and satisfaction with science, and the contribution of science to their learning. That is, when the gifted students' preference for metaphors that reflected favorable views about science, it can be seen that six students mentioned their love of science, and these statements were coded as "like." Examples from these students' metaphorical statements are as follows:

> *Science is like super because I like it.*
>
> *Science is like my love because I love it.*
>
> *Science is like a hobby I love to do because I love it and it is very important.*
>
> *Science is like my favorite item because I love being able to answer everything, and I also like talking about science.*
>
> *Science is like a good actor who is well-loved and important because science is also important.*

In addition to these metaphors having reflected the students' love of science, five of the students' favorable metaphors were also associated with fun, enjoyment, excitement, or happiness, and these metaphors were coded as "fun." The following are examples of these metaphors:

Science is like happiness because we are free and happy.

Science is like fun because I enjoy learning it.

Science is like pleasure because you need to work with your hands, it is exciting, and joyful.

Science is like a game because you have fun.

Additionally, four of the students mentioned the contribution of science to their learning and life. As such, the following statements were labeled as reflecting the "contribution" of science to their learning:

Science is like a lifesaver because you learn many things with the help of science.

Science is like a teacher because I learn many things.

Science is like learning because we learn with science, and it contributes to and makes our life easier.

Relating Metaphors

The findings revealed that some of the metaphorical perceptions from the analyzed student discourses focused on associating science with other concepts. In other words, in their metaphors, some of the students related science to other concepts, hence the category of "relating" emerged for these metaphors. In this category, most of the students associated science with experiments and experimentation, and chose related metaphors, of which the following are examples:

Science is like an experiment because you must try all possibilities.

Science is like an experiment because I like experimenting.

Science is like eating candy because it has lots of fun and tasty experiments.

Science is like an experiment because in science we learn by experimenting.

Science is like an experiment because science is an experiment.

Additionally, some of the students preferred using metaphors that mentioned science being associated with life, which is illustrated in the following:

Science is like a lifeguard because it is important for saving lives.

Science is like life itself because it describes life.

Science is like knowledge of life because it is the meaning of life.

Science is like life because everything in life is science and everything in science is life.

As can be seen, in the metaphors about science, a significant number of the students mentioned experiments, and thereby directly associated science with experimentation. In addition, three of the students expressed metaphorical perceptions about the relationship of science with other lessons, as can be seen in the following:

Science is like a social lesson because you learn new things.

Science is like an art lesson, because these two lessons are so nice since you start off with a blank page.

Science is like math because both require intelligence.

Metaphors Indicating Difficulty Level

The last category of the metaphorical perception findings regarding science consists of one student's opinion, whose metaphor related to the perceived difficulty of science. Since this data could not be determined as either favorable or relating, but was seen equally as an important finding, its own separate category was created:

Science is like trying to walk a hard road because it is difficult.

To summarize, findings obtained from gifted students' data about metaphors related to science were grouped into three categories, as students' favorable metaphorical perceptions as well as their ideas about the relationships and difficulty level of science. The categories, codes, frequencies, and percentages are summarized in Table 4.

Table 4. Metaphors regarding science

Category	Code	Frequency	Code %
Favorable	Contribution	4	12.9%
	Fun	5	16.1%
	Like	6	19.4%
Relating	Experiment	7	22.6%
	Lessons	3	9.7%
	Life	5	16.1%
Difficulty level	Difficulty	1	3.2%

Metaphors about School Science

The findings presented under this theme include the students' metaphorical perceptions about science lessons in their schools. When the metaphorical perceptions of the students towards science lessons at school were examined, it could be seen that the metaphors used were gathered under three categories, as "favorable" (60.8%), "relating" (32.1%), and "unfavorable" (7.1%), as can be seen in Figure 4. In the following subheadings, details about each category is addressed along with examples of the students' own metaphorical phrases.

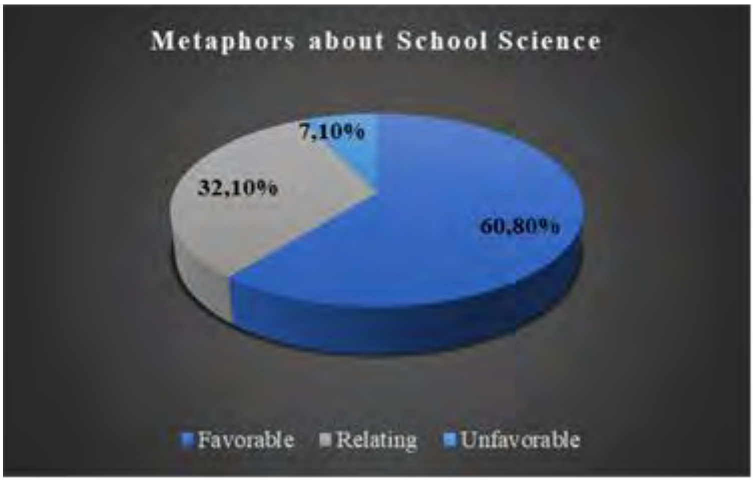

Figure 4. Categories of metaphors about school science

Favorable Metaphors

The findings reflected that the most frequently used metaphors in terms of the gifted students' perceptions about school science related to the discourses about students' positive perceptions of school science. In this category of "favorite metaphors," some of the students associated science lessons in their school with positive feelings and experiences of fun and excitement; for example:

> *Science lessons at school are like a game because they are lots of fun.*
>
> *Science lessons at school are like scoring a goal because it makes you feel good and excited.*
>
> *Science lessons at school are like a contest because everyone is crazy to answer.*

In addition to the students' metaphors that were coded as "fun," they also used metaphors focusing on the "contribution" of science lessons to their life, such as in the following:

> *Science lessons at school are like first aid because you are improving the lives of those in distress, and it helps you to develop.*
>
> *Science lessons at school are like a website at the school because you learn everything.*
>
> *Science lessons at school are like a tutor at school because you learn.*

Relating Metaphors

When the metaphorical perceptions of the participant gifted students towards their science lessons at school were examined, it was seen that they associated them with experiments as well as with different disciplines. Examples of the students' metaphorical expressions that related to experiments are as follows:

> *Science lessons at school are like different because we do experiments.*
>
> *Science lessons at school are like trying something new because it is full of experimentation.*

Moreover, two of the students associated their school science lessons with different social disciplines such as social lessons and art, as their statements show:

Science lessons at school are like social lessons because many things learned in social lessons are about science.

Science lessons at school are like art because it is very detailed.

Unfavorable Metaphors

Two students shared metaphors that reflected negative opinions held regarding school science, and their metaphoric perceptions under the unfavorable metaphors category were coded as "difficulty." The statements of the students who mentioned this metaphor are as follows:

Science lessons at school are like darkness because they are hard and I don't like them.

Science lessons at school are like difficulty because it's a bit confusing and I do not feel satisfied with it.

To summarize, findings obtained from the participant gifted students' data regarding metaphors related to school science were grouped into three categories, as students' favorable and unfavorable metaphorical perceptions, as well as their ideas about the relationship of school science with other disciplines/issues. The categories, codes, frequencies, and percentages are summarized as shown in Table 5.

Table 5. Metaphors regarding school science

Category	Code	Frequency	Code %
Favorable	Fun	12	42.9%
	Contribution	5	17.9%
Relating	Art/Social Discipline	2	7.1%
	Experiment	7	25.0%
Unfavorable	Difficulty	2	7.1%

5. DISCUSSION and CONCLUSION

The current study aimed to explore the metaphorical perceptions of gifted students towards mathematics, school mathematics, science, and school science. Based on this aim, the students' metaphors related to each theme were examined separately and the findings presented according to themes and categories.

In a general sense, three categories of findings were obtained across all four themes. For example, the categories of metaphors regarding mathematics were "favorable," "relating," and "difficulty level"; whilst regarding school mathematics they were "favorable," "relating," and "unfavorable." Similarly, categories of metaphors regarding science were "favorable," "relating," and "difficulty level"; whilst regarding school science they were "favorable," "relating," and "unfavorable." As seen, while some of these categories differed, some category titles were similar to each other. For instance, the participant gifted students' most preferred metaphors for mathematics and science, regardless of whether concerning general math/science or as school lessons, included codes based on positive emotions and experiences such as favorable, love, excitement, happiness, and fun. That is, the category with the highest frequency and percentage in each theme was the favorable category. This finding coincides with the studies of Bircan and Köksal (2020), Caleon and Subramaniam (2010), Hoover (1989), Kanlı (2017), Ugulu (2020), and Uzun (2006) in stating that gifted students exhibit interest and ability tendencies towards both mathematics and science. For this reason, the lesson content of students who possess a positive attitude, especially in the disciplines of science and mathematics, can be arranged accordingly by teachers based on the needs of their students' metaphorical perceptions. According to Van Püskül-Baska (1998), gifted students' intellectual progress and motivation tend to be stronger in science classrooms where teachers try to differentiate and vary the lessons according to the students. However, teachers are often unsuccessful in adequately meeting the needs of gifted individuals because they do not comprehend the distinctive qualities or educational needs of gifted students (Gallagher, 2000). In this regard, science and mathematics teachers who teach gifted students should ensure that they are familiar with their students' expectations. That is, teachers should know how their gifted students behave and perform in the classroom as science and math learners, and then find and employ appropriate techniques when teaching science and mathematics in order to fulfill the needs of all their students, gifted included.

In addition to the favorable category, "relating" also emerged in the current study as a category across all four themes. In this sense, the participant gifted students mentioned "life" in their metaphorical perceptions of mathematics, school mathematics, and science. In particular, gifted students especially need to learn the logic of events, as they naturally question the information they gain, and then apply and associate it within their own lives (Tomlinson, 2015). Thus, since they may find areas of their own lives in which science and mathematics are prominent, these fields may seem more meaningful to them, worthy of reflection, and relate more to their natural problem-solving skills and interests. That is, this may account for fields such as mathematics and science being perceived as more meaningful, interesting, and worthy of thought by gifted students, and in their solving of problems. In other words, since gifted students relate areas of their own lives to science and mathematics, they may exhibit a natural aptitude and interest in these areas.

Many studies in the literature have supported this position, with reports of gifted students exhibiting many behaviors that include mental risk-taking, such as questioning phenomena related to a problem, and by not focusing on a single result while solving scientific problems (Soares, 2016). It has been determined that gifted students with high-level thinking skills can exhibit high levels of mental performance especially in the science teaching process and are thereby more perceptive to these areas (Watters & Diezmann, 2003; Yurtkulu, 2019). Kanlı and Emir (2009) developed a science and technology program that aimed to meet the academic expectations of gifted students with different cognitive characteristics. According to the results of their research, it was determined that the motivation of gifted students increased because they made more use of the information they had learned in daily life. Rotigel and Fello (2014) stated that gifted students seek to learn more about mathematics in daily life, and defined this realization as a characteristic feature of gifted students. They also stated that students were able to reveal this desire to learn through being naturally motivated and curious about mathematics, by being persistent in their quest for knowledge, by being exploration-oriented and entrepreneurial, and through being actively involved in a wide range of interests.

Another striking point that is notable from the current study's findings relates to the category of "unfavorable," which appeared only for the two themes related to school subjects. In other words, when the findings are examined, it is noteworthy that while the participant gifted students did not offer any negative metaphors regarding either mathematics or science, they presented unfavorable perceptions in their metaphors when considering these subject areas in terms of their school lessons. That is, when the metaphorical findings on mathematics and school mathematics were analyzed through correlation and comparison, it could be seen that some students reported being less favorable about mathematics when it came to school mathematics. In this finding, a new category of "unfavorable" emerged that referred to the apparent perceived boringness of school mathematics. In addition, a similar case was also seen in terms of the science findings, where the unfavorable category was not evident in the science theme, but was observed in the school science theme. However, the reason identified for this lack of favorability was found to relate to the perceived difficulty of school science lessons. This is another finding that further supports that although gifted students may possess and exhibit different cognitive abilities, that they may be inadequately supported within the school environment, and may lack appropriate experience due to limitations in their schools having responded to their educational needs (Baykoç, 2014; Dimitriadis, 2016; Gadanidis et al., 2011; Law & Kaufhold, 2009; Uyaroğlu, 2011).

6. SUGGESTIONS

Metaphors are very important in knowledge production since they allow us to form concrete connections between abstract concepts and everyday experiences in life. An extensive literature suggests that metaphors shape the mind, structure our experiences, and influence our behaviors (Niebert & Gropengiesser, 2015). There are certain images that can help to explain life and the universe, and help the minds of students to relate the natural world to their science and mathematics education. Identifying these images and structuring the concepts to be taught in school can offer a positive and tangible difference to most education systems. For example, the intelligent design movement has benefited from scientists' use of machine metaphors, and continues to benefit in this area (Pigliucci & Boundry, 2011). For this reason, it is necessary to examine students' choices of metaphor and to create an appropriate roadmap in the determined areas. Additionally, it can help students to develop the necessary skills and competencies needed to identify metaphors, and to assess their strengths and limitations in conceptualizing abstract ideas, as well as to reveal more quantified social messages.

When we consider what the current educational environment portrays, the current study's findings have shown that gifted students may use positive metaphorical perceptions for the fields of mathematics and science, but that educational environments require a level of modification in order to accommodate students differentiating skills and needs. At this point, it is important to produce more specific and highly applicable solutions relevant to today's classrooms in terms of the needs and individual characteristics of gifted students. The importance of appropriate curricula and targeted teacher training is both apparent and essential.

The findings of the current study concentrated on the metaphorical perceptions of gifted students towards mathematics, school mathematics, science, and school science, and as such may contribute to the literature of math education, science education, as well as the field of gifted education.

The study's findings point to the need for additional studies in this area. For example, metaphorical perceptions of regular and gifted students could be compared. Moreover, expanding upon the current research with a quantitative study conducted in different samples and with greater numbers of students could also be a worthwhile exercise that would benefit the current literature. Through such an approach, more generalizable conclusions could potentially be drawn regarding these issues.

DECLARATIONS

Author Contributions: All authors have read and approved the final version of the article.

Conflicts of Interest: The authors declare no conflict of interest.

Ethical Approval: Ethical permission (dated March 10, 2022) was obtained from Istanbul Aydin University's, Social and Human Sciences Ethics Committee for this research to be conducted.

Data Availability Statement: To review the data from this study, contact the primary author for more discussion about the request. The data are not publicly available due to privacy or ethical restrictions.

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ABOUT THE CONTRIBUTORS

Duygu Ozdemir, PhD, is an Assistant Professor in the Faculty of Education at Istanbul Aydin University, Turkey. Her main research interests include gifted students and mathematics teaching. She has published extensively in leading international journals and has also written books and chapters on the teaching of mathematics.
Email: duyguozdemir5@aydin.edu.tr
ORCID ID: https://orcid.org/0000-0001-5841-3404

Aysegul Kinik Topalsan PhD, is an Assistant Professor in the Faculty of Education at Istanbul Aydin University, Turkey. Her main research interests include science education, argumentation, and ontology. She has published extensively in leading international journals and has also written books and chapters on the teaching of science.
Email: aysegulkinik@aydin.edu.tr
ORCID ID: https://orcid.org/0000-0003-0947-5355

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