

# Metaphorical perceptions of gifted and normally developing students on the concept of solving mathematical problems

Zübeyde Er<sup>1,\*</sup> , Perihan Dinç Artut<sup>2</sup> 

<sup>1</sup>Adana Science and Art Center, Adana, Turkey

<sup>2</sup>Cukurova University, Education Faculty, Mathematics and Science Education Department, Adana, Turkey

\*Correspondence: zbeyde-er@windowslive.com

Received: 29 April 2023 | Revised: 18 July 2023 | Accepted: 25 July 2023 | Published Online: 31 July 2023

© The Author(s) 2023

## Abstract

This research aims to determine the metaphorical perceptions of gifted and normally developing students attending primary education regarding solving mathematical problems. In the research, the qualitative research method was employed. In the 2022-2023 academic year, 206 students studying at the primary school level in Turkey were determined according to the convenience sampling method. Students were given a sentence such as **“In my opinion, solving mathematical problems is like ....., because; .....”** and they were asked to develop a metaphor about mathematical problem solving and explain their reasoning. The research data were categorized using qualitative data analysis methods, and content analysis was performed. In addition, the categories related to the metaphors created and the distribution of the students according to their gender, whether they are gifted or not, and gender were analyzed. From the analysis of the data, seven categories and 84 metaphors emerged. As a result of the data analysis showed that male students were more likely than female students, and gifted students were more likely to produce metaphors than students with normal development. In the seven conceptual categories for mathematical problem solving, 37 metaphors were developed in the conceptual category containing positivity, 16 in the conceptual category containing negativity, and 8 in the conceptual categories containing and developing necessity. Besides, it was seen that 15 metaphors were developed in conceptual categories of Drug Therapeutic, Goal or Result Attainment, Nature, and Natural Phenomena.

Keywords: Gifted Students, Metaphor, Middle School, Problem Solving, Special Talent

How to Cite: Er, Z., & Artut, P. D. (2023). Metaphorical perceptions of gifted and normally developing students on the concept of solving mathematical problems. *Journal on Mathematics Education*, 14(4), 627-646. <http://doi.org/10.22342/jme.v14i4.pp627-646>

Mathematics involves processing information, making predictions, and solving mathematical language problems. Emphasis was placed on problem-solving in the curriculum; problem-solving was among the objectives of the mathematics course and became one of the basic skills students should gain (Baykul, 2009). Pesen (2003) expressed problem-solving as revealing the relationships between new and existing situations and reaching results. Problem-solving also means creating effective solutions to new situations when confronted (Gail, 1996).

Students must acquire problem-solving skills. Yetim Karaca and Ada (2018) stated that a student's success in a course is directly related to his/her perception of that course. Metaphors are one of the most powerful mental tools that reflect and direct thoughts about phenomena (Saban, 2004) and are a process that requires creativity (Kačer, 2021). The literature has different views on the relationship between intelligence and creativity. With this research, it is thought that determining the metaphorical perceptions

of students with different intelligence levels regarding the concept of mathematical problem-solving will provide a perspective for teaching the concept of problem-solving and the relationship between intelligence and creativity, which differs in the literature. In this context, in this research, the metaphorical perceptions of gifted and normal-level students about solving mathematical problems were reviewed and comparatively examined.

### **A Look at the Concept of Problem Solving in Mathematics Education**

Individuals try to gain problem-solving skills by producing solutions to the problems they encounter most of their lives in mathematics. There are many definitions of problems and problem-solving in the field literature. Orton and Wain (1994) defined a problem as a situation that interests individuals and that individuals want to solve. Krulik and Rudnick (1985) defined the problem as an unknown solution. Problem-solving, on the other hand, is the ability to reason about what needs to be done to produce the right solution or solutions when the problem is encountered (Altun, 2015). Schoenfeld (2014) defined problem-solving as a concept that supports understanding the value of mathematics, developing creative thinking skills, and learning mathematical concepts. Mayer (2002) indicated that problem-solving is when students find a suitable solution to a new complex situation by referencing their old knowledge. Ülgen (2001) explained problem-solving as finding a solution that helps to cope with situations that prevent achieving the goal. NCTM (2000) defined problem-solving as the process of searching for a solution to a mathematical situation that requires reasoning and thinking and whose solution is unknown. Mathematical problem-solving is an activity that creates a model (Lesh & Zawojewski, 2007), a logic-based program (Newell & Simon, 1972), an intuitive process (Polya, 2004), a new attempt to solve the problem with what has already been gained (Krulik & Reys, 1980), a standard (National Council of Teachers of Mathematics [NCTM], 1989), and an inductive-deductive exploratory tool (Polya, 2004; Lakatos, 1976).

Individuals need problem-solving skills to do mathematics (Polya, 2006). Problem-solving skills contribute to developing **cognitive strategies** (Yıldızlar, 2012) and creative thinking in learning mathematics (Silver, 1997). In addition, problem-solving allows individuals to explore mathematical relationships and express their thoughts orally or in writing (Gür & Korkmaz, 2003). Yetim Karaca and Ada (2018) indicated that students who were good problem solvers in mathematics class were also talented in solving daily life problems. The National Council of Mathematics Teachers (NCTM, 2000) also stated that problem-solving should be the cornerstone of mathematics. Having problem-solving skills is essential among the objectives of education and training systems. Therefore, the concept of problem-solving and increasing success in problem-solving are subjects that many psychologists and educators work on (Kılıç & Samancı, 2005).

Posamentier and Krulik (2016) focused on the place of problem-solving skills in the curriculum and stated that it is a fundamental part of the curriculum. Societies consisting of individuals who can solve problems have the potential to give their countries a say in the future. Therefore, countries need to focus on problem-solving skills in their training programs. In the mathematics payment curriculum of the Ministry of National Education (2018), it is stated that individuals who have mathematical competence are expected to have gained problem-solving and building skills, and among these general objectives is the **article: "The student will be able to easily express his thinking and reasoning in the problem-solving process and will be able to see the deficiencies or gaps in the mathematical reasoning of others."**

In the international literature, as in Turkey, it is known that problem-solving skills are given a wide place in the curriculum of countries and that many countries put problem-solving at the center of mathematics. In many countries, mathematics curricula consist of subject lists, learning areas, content,



and/or a range of processes. A series of processes cover actions related to using and applying mathematics to solve problems. For example, in Singapore, problem-solving is at the center of the curriculum and depends on five essential components: skills, concepts, processes, attitudes, and metacognition. Similarly, in the UK's mathematics curriculum, problem-solving is stated as 'at the heart of mathematics' (Uzun et al., 2022).

Individuals' approaches to the problem differ (Yıldırım, Hacıhasanoğlu, Karakurt, & Türkleş, 2011) and are influenced by their beliefs and experiences about themselves (Fitzpatrick, 1994). Yetim Karaca and Ada (2018) stated that a student's success in a course is directly related to his/her perception of that course. Therefore, it is crucial to determine the thoughts and perceptions of the students about the mathematics problem. Metaphors are one of the most powerful mental tools that reflect and guide our thoughts about facts (Saban, 2004). This research used metaphors to reveal students' perceptions of mathematical problem-solving.

### The Concept of Metaphor

The metaphor, which is based on the Greek and is stated to be formed by the combination of the words "Meta," which is used to change, and "pherein", which is used in the sense of carrying (Levine, 2005), and first explained by Lakoff and Johnson; making a well-known concept or situation known by likening it to another concept or situation is explained as the transfer of meaning (Balci, 2011; Lakoff & Johnson, 2005, Nikitina & Furuoka, 2008). Metaphor is the expression of a word using parables instead of its known and accepted meaning (Anılan, 2017). Senemoğlu (2005) explained the concept of metaphor as the relationship of new knowledge by finding similarities with previously known old knowledge and making sense of new knowledge. Dickmeyer (1989) refers to it as "explaining a phenomenon in familiar terms".

Metaphor connects the object or phenomenon we want to understand to a network of concepts belonging to another realm of meaning, allowing us to reconceptualize, see from different directions, and illuminate previously overlooked situations (Taylor, 1984). Metaphors govern our daily thoughts and actions, consciously or unconsciously. Metaphors appear as nouns, verbs, or qualifiers in everyday speech (Palmquist, 2001). Individuals act with the knowledge, skills, habits, and attitudes that exist when interpreting and using metaphors. Therefore, metaphors cannot be abstracted from the past experiences, prior learnings, and social environment of the individual who constitutes the metaphor. In these respects, metaphors used in educational environments have essential functions (Oğuz, 2009).

Metaphors are a method used to express feelings and thoughts (Dayı, Açıkgöz, & Elçi, 2020). With metaphors, the outward reflection of the inner world of individuals and the effects of how they interpret events and phenomena can be seen (Arslan & Bayrakçı, 2006). The concept of metaphorical perception is the process of forming thoughts through metaphor (Eraslan, 2011). It has been explained that data are obtained in educational sciences as in many fields through metaphor, that the program is structured thanks to these data, and that the use of metaphor has an essential function as a cognitive tool because it creates the depth of thinking (Eker & Sıcak, 2016; Zheng & Song, 2010).

There are individual differences between students. One of the groups of students who differ individually is the students with special abilities. Gagné (2004) expressed the concept of unique ability as the individual's intelligence age being above normal and performing at a high level in reasoning and abstract thinking skills. Gifted individuals have a high level of sense of duty creative skills, and above-average academic ability (Renzulli, 1978). In Turkey, according to the Science and Art Centers (SAC) directive, which was established for the education of individuals with superior abilities, superior talent is defined as "An individual who is faster learner than his peers, who have creativity, art, leadership capacity in the forefront, who has special academic ability, who can understand abstract ideas, who likes to act

independently in areas of interest, and who performs at a high level” (Ministry of National Education [MoNE] Journal of Communiqués, 2019). Metaphor creation involves a series of processes that require creativity. The literature has different opinions on the relationship between intelligence and creativity.

Regarding the relationship between intelligence and creativity, Feist and Barron (2003) in their study explained that a high level of intelligence does not guarantee a high level of creativity, that there is not a very high correlation between creativity and intelligence, and that a more intelligent individual does not mean a more creative person. These studies support the view that, in contrast with the fact that creativity is often associated with the enigmatic traits of gifted individuals and their extraordinary capacities (Rubinstein, 2003), creativity is a feature that is innately inherent in the individual, which can be learned over time (Edwards, 2001; Winner, 1997). Due to these different views in the literature, the perceptions of gifted students (IQ score 130 and above) and students with normal development toward mathematical problem-solving were discussed comparatively.

### The Objective of the Research

In the literature of the field, there are metaphor studies on the concepts of “mathematics”, “mathematics problem,” “mathematics teacher,” “problem building,” and “teaching mathematics problem solving” (Arıkan, 2014; Allen & Shiu, 1997; Cassel & Vincent, 2011; Latterell & Wilson, 2016; Sterenberg, 2008; Solomon & Grimley, 2011; Schinck, Neale, Pugalee, & Cifarelli, 2008). The metaphorical perceptions of primary and secondary school students about the concept of problem-solving are discussed (Ayvaz Can, 2021; Sezgin Memnun, 2015; Yee, 2017; Yee & Bostic, 2014), whereas the metaphorical perceptions of teacher candidates are discussed (Saka & Durmuş, 2021; Uygun et al., 2016). Within the available resources, there have been no studies in which the perceptions of gifted and typically developing primary school students about mathematical problem solving are tried to be determined together. In addition, it was wondered what kind of metaphors the students created about problem-solving, under which concept categories were gathered in terms of common characteristics of metaphors, and how the concept categories were distributed according to various variables (gender, giftedness, or not). The fact that mathematics problem-solving skills are among the basic skills of the 21st century and that institutions value mathematics problem-solving skills more (Vordermann, Porkess, Budd, Dunne, & Rahman-Hart, 2011) shows that this research is current and necessary. Choi and Kim (2016) noted that analogical and metaphorical reasoning can be used as a teaching strategy to develop students' creative thinking during the design process. This research considered that the comparative consideration of perception against the mathematical problem-solving concept of gifted and typically developing students could contribute to teaching problem-solving skills. This **research aims to determine the students' thoughts on mathematical problem-solving through metaphors**. For this purpose, the following research questions were tried to be answered:

1. What categories **emerge in students' metaphors for “mathematical problem solving”**?
2. The categories that emerged in the metaphors students used about "mathematical problem solving",
  - 2.1. How is it distributed according to gender?
  - 2.2. How is it distributed according to the status of gifted-normally developing students?
3. What kind of metaphors do students use to express mathematical problem-solving?



## METHODS

### Research Model

This research is a qualitative study aimed at determining the thoughts of gifted-diagnosed students studying in Science and Art Centers (SAC) with the help of metaphors regarding the concept of **“mathematical problem solving” in Adana province of the southern region of Turkey**. This study used the case science method based on a qualitative research approach. Phenomenological research examines **what individuals’ experiences are about the phenomena they encounter in the environment in which they live**. Using this method, researchers conduct interviews with individuals, trying to determine the **individual’s perception of the phenomenon (McMillan & Schumacher, 2010)**.

### Study Group

The study group consists of 106 gifted students who have already been determined to be gifted by the exam conducted by the Ministry of National Education and 100 students with normal development studying in Adana. Individuals with exceptional abilities in Turkey are diagnosed by the national examination conducted by the Ministry. Diagnosis is expressed as all quantitative and qualitative measurements made to accurately determine the student's needs and to provide the necessary educational service to the student in line with these requirements. In Turkey, gifted people are diagnosed in 5 stages.

1. Stage 1: SAC announcement phase
2. Stage 2: Filling out observation forms by classroom teachers
3. Stage 3: Evaluation of forms
4. Stage 4: Group screening
5. Stage 5: Individual review

The primary stages in the diagnosis of gifted are the 4<sup>th</sup> and 5<sup>th</sup> stages, in which students who succeed in the group screening are evaluated individually. In this individual evaluation, the intelligence test preferred by the Ministry of National Education is applied. In 2015, WNV, or the Wechsler intelligence test, was applied to 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup>-grade students who applied to SAC. In 2016, while the Kbit or Kaufman short intelligence test was applied to the first and second grades, the WNV test was applied to the third and fourth grades. In 2017, ASIS, namely the SAK Intelligence Scale, was applied to first and second-year students in SAC auditions, while the WNV test was applied to third-year students. A new regulation is made every year in SAC intelligence tests, and it is preferred to change the tests. In this context, it is impossible to discuss a particular intelligence test every year, and individuals with an IQ score of 130 and above are defined as gifted. In addition to the formal education activity in their schools, individuals diagnosed as gifted receive education according to the talent area (General Ability, Painting, Music) in SAC. In the diagnostic system applied in Türkiye, a talent diagnosis is not explicitly made in mathematics. In SAC, the educational programs of the students admitted to the center from the branches of general mental ability, painting, and music are arranged as five semesters. These are the Adaptation period, the Support period, the period of recognizing individual talents, the period of developing special talents, and the Project period. In this process, gifted individuals in mathematics direct them to mathematics classes where they will develop projects related to mathematics. In this study, an easily accessible situation sampling method was adopted to determine the working group. Demographic information on the study group is presented in [Table 1](#).

Table 1. Findings on Demographic Characteristics of the Students

Variables		f	%
Gender	Female	100	48,54
	Male	106	51,46
Students	Gifted	106	51,46
	Developing normally	100	48,54
Total		206	100

According to Table 1, 48.54% of the 206 students participating in the research were female, and 51.46% were male students. In addition, 51.46% of the students were diagnosed as gifted, and 48.54% were students with normal development. In addition, the study group of the study consists of students at different grade levels studying in secondary school.

### Data Collection Tool and Collecting Data

The form developed by the researcher and used as a data collection tool consists of two parts. In the first part, to determine the demographic information about the students, whether they are science and art center students, and their gender are asked. The second part contains an open-ended metaphor question for research purposes. Creswell (2007) noted that open-ended questions allow participants to express their feelings and thoughts freely. The draft questionnaire, which is intended to be applied to the students, was first shown to 2 experts, one of whom was a Turkish educator and one of whom was a mathematics educator, and their opinions were obtained. In line with the expert opinions, the students who participated in the research were asked with the following sentences: "In my opinion, solving mathematical problems ..... is like. Because; .....". Students were asked to develop a metaphor about mathematical problem-solving and explain their rationale.

The research data were collected via Google form in the fall semester of the 2022-2023 academic year. The necessary permissions for the collection of data have been obtained. The Google form tells students that participation in this research is voluntary and that students who do not want to participate do not have to answer. In addition, it has been explained that there is no information such as name or student number in the Google form that will determine the identity of the students to the surveys and that the results of the survey will only be used by the researcher for scientific work and will not be shared with other institutions or organizations.

### Data Analysis

The data obtained by the students who voluntarily agreed to participate in the research were read individually by the researcher. In the analysis of the data, the following stages were followed respectively.

1. During the first reading, questionnaires containing demographic data were excluded from the evaluation of surveys that were not filled out by students or were incompletely filled in (12 units), and students did not answer the part with open-ended questions or whose justification was not explained (34 units).
2. Secondly, 206 questionnaires for the research were transferred to the Excel file and recorded for classifying metaphors and creating conceptual categories.
3. In classifying metaphors and creating conceptual categories, the answers given to the evaluated questionnaires were re-read and analyzed using the content analysis technique. Content analysis is the thematic analysis of data in terms of specific categories by scanning it systematically. The data obtained in content analysis identifies, counts, and interprets recurring topics, problems, and



concepts (Denzin & Lincoln, 2008; Miles & Huberman, 1994; Silverman, 2000). In other words, the data obtained by content analysis are classified between each other and specific themes, thus revealing the relationships between the data (Yildirim & Şimşek, 2011).

4. As a result of the analysis, an alphabetical list of the metaphors obtained due to examining all metaphors was made, and a file was filed with metaphor samples. Examining all the metaphor examples obtained, they are divided into conceptual categories regarding their standard features and subcategories in some conceptual categories.
5. Each metaphor is associated with a specific conceptual category, and 84 metaphors and seven different conceptual categories are created based on the purpose of use.
6. For the metaphors that are separated according to conceptual categories, frequency tables are created that show the level of education of the student, his/her gender, and whether he/she is gifted or not. In addition, the metaphors created by the students obtained from the data were presented separately according to the student's education level, gender, and whether they were gifted or not.

In the results section, after the tables, a sample explanation of the reason for the metaphors used by the students is presented. In the explanations of who produced the metaphor image and the reason, the demographic characteristics of the students are shown with symbols. While giving these examples, codings were made using symbols in the forms of explanations in parentheses: gender (F=girl, M= boy), whether or not he is gifted (Special Talented= ST, Normally Developing = ND), grade level (5, 6, 7, 8).

### Measures Regarding the Validity and Reliability of the Research

Direct student statements were included to ensure the validity of the research. To ensure the reliability of the research, independently of each other, the researcher and an expert have thrown all the metaphors according to the seven categories (containing positivity, containing negativity, containing necessity, developing, drug therapeutic, goal or result achievement, nature, and natural phenomenon) created. The reliability of the assignment of all metaphors by category was calculated using the formula:  $\text{Reliability} = \frac{(\text{Consensus})}{(\text{Consensus} + \text{Disagreement})} \times 100$  (Miles & Huberman, 1994), and it was seen that a reliability of .97 ratio was achieved.

## RESULTS AND DISCUSSION

Eighty-four metaphors and seven categories were created by taking expert opinions for the metaphors that were examined in this section and produced by a total of 206 students and that expressed similar, or the same meaning produced for the concept of “mathematical problem solving”. The categories created and the subcategories in some categories are presented in Figure 1.

### Findings on the Metaphors Developed by Students for Solving Mathematical Problems

A total of 206 students, 106 gifted students and 100 students with normal development, who were in the study group, were grouped into seven different conceptual categories and 84 metaphors for the concept of solving mathematical problems. The frequency of use of conceptual categories created from the developed metaphors is given in Figure 1 in graphical form.



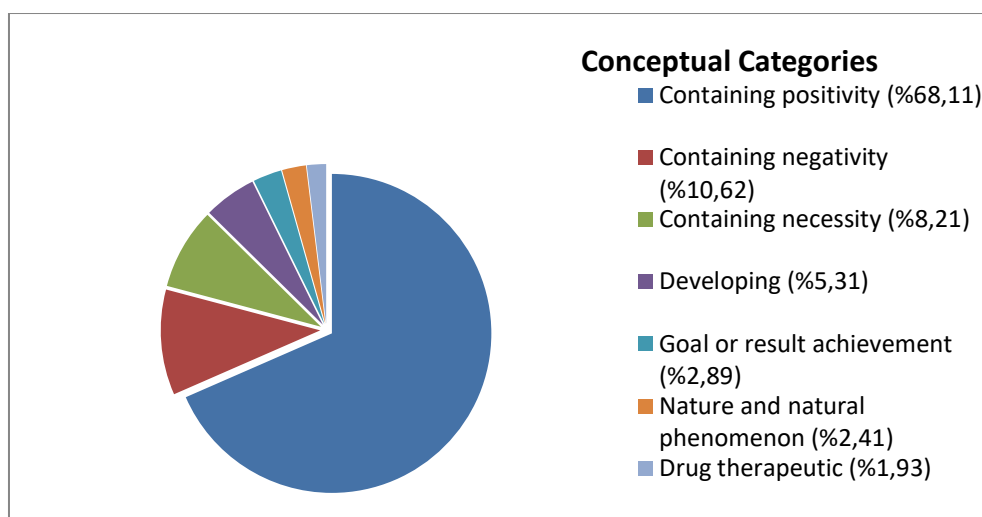


Figure 1. Scatter chart of Conceptual Categories consisting of metaphors

In Figure 1 for the concept of “Mathematical problem solving”, metaphors are listed as follows: “containing positivity” ( $n=141$ , 68.11%), “containing negativity” ( $n=22$ , 10.62%), “containing necessity” ( $n=17$ , 8.21%), and “developing” ( $n=11$ , 5.31%) in the third place. In addition, there are also categories containing “drug therapeutic”, “goal or result achievement,” and “nature and natural phenomenon” that are below 5%.

According to the content of the metaphors produced by the students, subcategories were defined in the conceptual categories of “containing positive” and “containing negativity”. In Table 2, the distribution of conceptual categories and subcategories according to the gender of the students, their giftedness is given.

Table 2. Frequency and percentage distribution of conceptual categories and subcategories according to student characteristics

Conceptual Categories	Subcategories	Female	Male	Gifted	Developing normally	Total
		f (%)	f (%)	f (%)	f (%)	f (%)
Containing positivity	To be easy	6	13	11	8	19 (%9,2)
	To like to solve problems	35	43	41	37	78 (%37,86)
	To find it fun	22	22	23	21	44(%21,35)
	Total	63 (%63)	78(%73,58)	75(%70,75)	66 (%66)	141(%68,11)
Containing negativity	To be hard	7	8	5	10	15 (%7,28)
	To contain complexity	6	1	2	5	7 (%3,39)
	Total	13 (%13)	9 (%8,49)	7(%6,60)	15(%15)	22 (%10,62)
To contain necessity	Total	9 (%9)*	8 (%7,54)	10 (%9,43)	7 (%7)	17 (%8,21)
To improve	Total	7(%7)	4 (%3,77)	5 (%4,71)	6 (%6)	11 (%5,31)



To achieve a goal or result	Total	2(%2)	4 (%3,77)	5 (%4,71)	1 (%1)	6 (%2,89)
To contain nature and natural phenomena	Total	3(%3)	2 (%1,96)	4 (%3,77)	1 (%1)	5 (%2,41)
Drug therapeutic	Total	3(%3)	1 (%0,97)	-	4 (%4)	4 (%1,93)
	Total	100*	106*	106*	100*	206*(%100)

\*: The percentage value among the total students in the column

-: No metaphor has been produced by any student who responds in this category.

In [Table 2](#), for the concept of “Mathematical problem-solving,” 63% of female students, 78.58% of male students, 70.75% of gifted students, and 66% of students with normal development developed metaphors in the conceptual category of “containing positivity.” In addition, in the subcategories of the conceptual category, which contains positivity about the concept of mathematical problem solving, 9.22% of all students developed metaphors that problem-solving is easy; 37.86% of them developed the metaphor, ‘to like to solve problems’; and 21.35% of them developed metaphor ‘to find problem-solving fun.’ In addition, for the concept of “Mathematical problem solving,” 13% of female students, 8.49% of male students, 6.60% of gifted students, and 15% of students with normal development produced metaphors in the conceptual category of “containing negativity.” Among the participants, it can be said that male students produced metaphors in the conceptual category of “containing positivity” more than female students, and students with normal development produced metaphors in the conceptual category more than gifted students. In addition, it is seen that female students produce metaphors in the conceptual category of “negative” more than male students, and students with normal development more than gifted students.

### Metaphors Produced in the Conceptual Category of Positivity

Metaphors in the conceptual category that include positivity from the metaphors developed by 141 students, 75 students with unique abilities, and 66 students with normal development related to mathematical problem-solving include 37 metaphors. The metaphors produced in this category are given in [Table 3](#).

Table 3. Metaphors Produced in the Conceptual Category of Positivity

	Metaphors	Toplam
Gifted	baby work(f:1), child-bay toy(f:7), puzzle(f:4), entertainment(f:12), funny(f:4), snack(f:5), labyrinth(f:1), game(f:10), playing games(f:5), jigsaw puzzle(f:1), chocolate(f:1), candy(f:1), cake(f:1), sweet(f:2), watching movies(f:1), party(f:1), habby(f:3), race(f:1), pleasant(f:2), pleasure(f:2), happiness(f:2), great(f:1), beautiful(f:3), color(f:1), boring(f:1)	25
Developing normally	child-bay toy(f:10), puzzle(f:2), entertainment(f:7), funny(f:7), snack(f:2), game(f:2), chocolate(f:1), hobby(f:3), race(f:1), pleasure (f:10), happiness(f:2), beautiful(f:5), piece of cake (f:1), like 2+2=4 calculation (f:1), a task (f:2), favorite (f:1), activity (f:2), football (f:1), peeling	24

	tangerine (f:1), drawing a picture (f:1), chewing gum (f:1), gold (f:1), love (f:2), curiosity (f:1).	
Total		25+24- 12=37

According to [Table 3](#), of the 37 metaphors, 13 were created only by students with special talents, 12 were formed only by students with typical development, and both groups formed 12. Some examples of statements in the conceptual category that contain positivity from the metaphors developed for mathematical problem-solving are given below.

- M<sub>7</sub>/ND/7: It is like curiosity. Because when I go to math class, I get excited and love it.  
 F<sub>12</sub>/ND/8: It is like eating a jar of Nutella. I eat as I eat it because I love Nutella, so when I solve math, I solve it as much as I solve it.  
 M<sub>29</sub>/ND/7: To draw pictures. I like painting and solving questions in mathematics.  
 F<sub>27</sub>/ND/6: It is like a baby toy. It is easy, I can understand it, and I do it again every day.  
 F<sub>24</sub>/ND/7: Entertainment. Numbers come to me like a game, and I have fun.  
 F<sub>19</sub>/ND/7: It is like pleasure. Because solving questions in math sounds fun.  
 M<sub>5</sub>/ND/6: Football. It is enjoyable.  
 F<sub>3</sub>/ND/6: Puzzle. I have fun solving problems as if I were doing puzzles.  
 M<sub>3</sub>/ND/6: Entertainment. Because problem-solving is a lot of fun.  
 F<sub>7</sub>/ST/6: Sweet. It gives pleasure.  
 F<sub>4</sub>/ST/5: Party: Because I am having fun.  
 M<sub>4</sub>/ST/5: It is like a puzzle. Because I enjoy solving it.  
 F<sub>68</sub>/ST/6: Jigsaw. In mathematics, putting the right pieces into consciousness and a little attention in place is very easy.  
 M<sub>94</sub>/ST/5: Cake. I like sweets so much.  
 M<sub>42</sub>/ST/5: Sweet. It makes you happy.  
 M<sub>47</sub>/ST/5: It is boring. Because it is easy.

### Metaphors Produced in the Conceptual Category of Negativity

The metaphors in the conceptual category that contain 'negativity' related to the concept of mathematical problem solving were developed by 22 students, including seven students with extraordinary ability and 15 students with typical development, including 16 metaphors. The metaphors produced in this category are given in [Table 4](#).

Table 4. Metaphors Produced in the Conceptual Category of Negativity

	Metaphors	Total
Gifted	a toy to be established (f:1), pepper (f:1), sumac (f:1), salted ice cream (f:1), brain-burning (f:1), doing a difficult task (f:2),	6
Developing normally	doing a difficult task (f:2), cruelty (f:1), a very difficult life (f:1), solving puzzles (f:1), boring (f:1), stress (f:1), untying an unfolding knot (f:2), punishment (f:1), confusion (f:3), something impossible (f:1), eating apples (f:1).	11
Total		6+11-1=16



According to Table 4, of the 16 metaphors, five were created only by students with special talents, ten were formed only by students with typical development, and both groups formed one. Some example statements in the conceptual category that contain entertainment from the metaphors developed for mathematical problem-solving are given below.

M<sub>36</sub>/ND/6: It is like eating an apple. Usually, I am very comfortable, but sometimes I cannot swallow the core questions. So, I need help figuring it out. But I usually figure it out.

M<sub>33</sub>/ND/8: Boring. I do not enjoy it.

M<sub>77</sub>/ND/5: It is like untying a knot. Because I am trying very hard to solve it.

F<sub>71</sub>/ND/8: Tough challenge. I cannot do it; I try to 1 question for hours, but I cannot solve it.

M<sub>57</sub>/ST/5: **It is like doing other people's work. Because in problem sentences, we solve the questions of others. It is like Uncle Ali and Aunt Ayşe.**

F<sub>77</sub>/ST/8: It is like a toy that needs to be set up. It needs to be dealt with.

M<sub>58</sub>/ST/5: Salted ice cream. Some are very difficult; some are very easy.

### Metaphors Produced in the Conceptual Category of Necessity

The metaphors in the conceptual category that contain 'necessity' related to mathematical problem solving were developed by 17 students, including ten students with extraordinary ability and seven students with typical development, including eight metaphors. The metaphors produced in this category are given in Table 5.

Table 5. Metaphors Produced in the Conceptual Category of Necessity

	Metaphors	Total
Gifted	obligation(f:1), life(f:3), need (f:1), oxygen (f:1), important (f:3), drinking water-eating (f:1)	6
Developing normally	obligation(f:1), life (f:1), important(f:1), drinking water-eating(f:2), subject support (f:1), exam (f:1).	6
Total		6+6-4=8

According to Table 5, of the eight metaphors, two were created only by students with special talents, two were formed only by students with typical development, and both groups formed four. Some example statements in the conceptual category that contain necessity from the metaphors developed for mathematical problem-solving are given below.

F<sub>26</sub>/ST/8: Imperative. I am a student, and an important lesson for my future.

F<sub>39</sub>/ST/6: Like my life. Because I associate it with my life.

F<sub>18</sub>/ND/7: Important. Solving problems in mathematics is, in my opinion, brain training.

M<sub>25</sub>/ND/6: Drinking water. It feels easy because I understand the subject.

M<sub>83</sub>/ND/5: It is part of life. It is a branch that you will apply at every moment of our lives.

F<sub>37</sub>/ST/5: It is like oxygen. It is necessary for us at every moment of our lives.

### Metaphors Produced in the Conceptual Category of Improvement

The metaphors in the conceptual category that contain 'improvement' related to the concept of mathematical problem solving and developed by a total of 11 students, including five students with extraordinary ability and



six students with typical development, include a total of 8 metaphors, including a total of 16 metaphors include a total of 8 metaphors. The metaphors produced in this category are given in [Table 6](#).

Table 6. Metaphors Produced in the Conceptual Category of Improvement

	Metaphors	Total
Gifted	playing video games(f:1), solving puzzles(f:1), box game (f:1), getting out of labyrinth (f:1), information (f:1)	5
Developing normally	solving puzzles(f:3), significant(f:1), using his/her brain(f:1), mind exercise (f:1)	4
Total		5+4=9

According to [Table 6](#), of the eight metaphors, four were created only by students with special talents, and three were formed only by students with typical development, both groups of students formed one. Some example statements in the conceptual category that contain 'improvement' from the metaphors that were developed for the concept of mathematical problem-solving are given below.

M<sub>103</sub>/ST/8: It is like playing a computer game. You improve as you solve.

F<sub>44</sub>/ST/5: Solving puzzles. It is both fun and requires us to exhaust our brains.

F<sub>63</sub>/ST/5: It is like the Board Game. As you do, you need to think about things as you progress.

F<sub>65</sub>/ST/5: It is like coming out of the maze. There are some clues you take it out by finding it. I reach the conclusion by finding certain numbers in the problem.

F<sub>84</sub>/ST/8: It is like knowledge. Each question gives color to my life.

F<sub>36</sub> /ND/5: Solving puzzles. I try to find it before anyone else and want to give the best answer.

F<sub>49</sub> /ND/5: It is very important. A lesson that develops our very meaningful brain and at the same time we can have fun.

M<sub>96</sub> /ND/5: Using your mind. Using your mind, you solve questions with logic.

F<sub>99</sub> /ND/5: Brain training. When I try to solve problems, my brain turns on.

### Metaphors Produced in Other Conceptual Categories (Including Drug Therapeutic, Goal or Result Attainment, Nature, and Natural Phenomenon)

The metaphors in the conceptual category that contain 'drug therapeutic, goal or result achievement, nature, and natural phenomena' related to the concept of mathematical problem solving and developed by a total of 15 students, including nine students with special ability and six students with normal development include a total of 6 metaphors. The metaphors produced in this category are given in [Table 7](#).

Table 7. Metaphors Produced in Other Conceptual Categories

Conceptual Categories	Metaphors	Toplam
Drug	Gifted	-
Therapeutic	Developing normally	therapy (f:2), napping (f:1), dream (f:1),
		4



Goal or Result Attainment	Gifted	attracting a heavy object (f:1), solving daily life problems (f:1) unlocking(f:1), chain (f:1). ladder (f:1),	5
	Developing normally	reading a book (f:1)	1
Nature and Natural Phenomenon	Gifted	rose (f:1), hell (f:1), rain (f:1), ocean (f:1),	4
	Developing normally	death (f:1)	1
Total			15

According to Table 7, of the 15 metaphors, 9 were created only by students with special talents, 6 were formed only by students with normal development. Some example expressions in the conceptual categories of drug treatment, goal or result achievement, nature and natural phenomenon from the metaphors that develop the concept of mathematical problem solving are given below.

F<sub>83</sub>/ST/7: Solving problems in my life. Math is very good for me.

F<sub>90</sub>/ND/8: A nap. It relaxes me.

F<sub>14</sub>/ND/7: Death. I do not understand.

F<sub>32</sub>/ND/6: Therapy. My favorite course.

F<sub>66</sub>/ST/8: Solving problems in math classes is like a ladder for me. Because every problem has solution stages. For some, sometimes it is different and sometimes the same, but in the end, a solution is reached by advancing a path. For example, in a problem that we could not solve, we came to a certain step and found the result wrong. We can understand which step we have reached in solving this or what kind of step we need to follow next. We can compare this to a ladder and think of the last step of the ladder as a solution.

M<sub>65</sub>/ND/6: Dream. I relax when solving questions in math.

M<sub>64</sub>/ND/5: It is like reading book. The book comes to an end. His problem comes to an end. By the end of the event, I will have understood the problem or the book in any way.

M<sub>67</sub>/ST/ 7: Chain with connection. An incorrect operation results in an incorrect operation.

F<sub>100</sub>/ST/6: Rose. Beautiful as roses but conspicuous as their thorns.

M<sub>94</sub>/ST/5: Ocean. Because sometimes it suffocates.

M<sub>88</sub>/ST/5: It is like shooting an object that I like heavily. As a result, I achieved what I want to my goal.

In the seven conceptual categories for mathematical problem solving, 37 metaphors were developed in the conceptual category containing positivity, 16 in the conceptual category containing negativity, and 8 in the conceptual categories containing and developing necessity. Besides, it was seen that 15 metaphors were developed in conceptual categories of Drug Therapeutic, Goal or Result Attainment, Nature, and Natural Phenomena. In addition, it was observed that gifted students produced more metaphors than students with normal development in all categories except for the conceptual categories of negativity and drug therapeutic.

In this research, which aims to determine the metaphorical perceptions of gifted and normally developing students attending primary education regarding solving mathematical problems, 84 metaphors and seven categories were created by 206 students. In the metaphors that students develop for the concept of mathematical problem solving, **it was seen that it was ranked as “containing positive”**

in the first place, “containing negativity” in the second place, “containing necessity” in the third place, and “improving” in the fourth place. In addition, categories were also established containing “drug therapeutic,” “goal or result achievement,” and “nature and natural phenomenon” that were below 5%. According to the content of the metaphors produced by the students, the subcategories of finding mathematical problem-solving easy, liking problem-solving, finding problem-solving fun, finding problem-solving difficult, and finding problem-solving **complex were also defined in the conceptual categories of “positive” and “negative.”** In addition, it was seen that a total of 84 metaphors were developed from 7 conceptual categories obtained from the student's answers to the concept of mathematical problem solving, including 37 in the conceptual category containing positive, 16 in the conceptual category containing negativity, 8 in the conceptual categories containing necessity and developing, and 15 in the conceptual categories including drug therapeutic, goal or result from attainment, nature, and natural phenomenon. Of the 84 metaphors, 31 were created only by students with unique talents, 33 were formed only by students with normal development, and both groups formed 20.

When the number of metaphors developing in all categories was examined, it was seen that gifted students produced more metaphors than students with typical development in all categories except for the conceptual categories of containing negativity and drug therapeutic. One of the reasons for this situation may be because data were obtained from 106 gifted and 100 typically developing students in the study. Another reason for this situation may be related to the fact that metaphor-making is a skill that requires creativity. **Kaçer (2021)** stated that creating metaphors includes a series of processes that require creativity. Gifted individuals have high creativity and above-average academic ability (Gagné, 2004). The findings of the literature partially support this finding of the study.

It was seen that most of the students participating in the study (n=141, 68.11%) had a positive perception of solving mathematics problems. In addition, it was seen that male students produced metaphors more than female students, gifted students more than students with normal development, and most **students produced metaphors in the “positive” conceptual category.** The metaphors in which the students express their positive perceptions towards problem-solving **are as follows:** “baby work, child-baby toy, puzzle, fun, entertainment, easy, labyrinth, game, playing games, puzzle, chocolate, candy, cake, dessert, watching movies, party, hobby, race, enjoyable, pleasure, happiness, wonderful, beautiful, color, boring, piece of cake, like  $2+2 = 4$  calculation, a task, favorite, activity, football, peeling a tangerine, **drawing a picture, chewing gum, gold, love, curiosity**”. In addition, most students produced metaphors expressing that they liked to solve mathematical problems (37.86%) and found it fun (21.35%). In addition, some students produced metaphors that stated they found it easy to solve mathematical problems (9.2%).

Özsoy (2005) stated that students who successfully solve problems are generally successful in mathematics lessons. Just as problem-solving success increases math success, it increases the **individual's problem-solving success** and, therefore, their positive perception of problem-solving or that problem-solving is easy. The reason why gifted-diagnosed individuals have a more positive perception of mathematical problem-solving than students with normal development may be due to their differences. **Arikan (2014)** obtained data from gifted and normal developing students in his study, which aims to question whether students who offer more than one solution to a mathematics problem are more successful in establishing a mathematics problem than students who cannot produce alternative solutions and to obtain the thoughts of students about problem building with the help of metaphor. As a result of the research showed that gifted students produced predominantly negative metaphors about problem building and that a large part of normal talented students evaluated problem building as complex and



challenging. In the metaphors developed with problem building similar to mathematical problem solving, students diagnosed with normal ability create metaphors that contain more negativity. From here, it can be seen that the research finding is in line with the field literature.

It was observed in the study that a portion of the students participating in the study ( $n=22$  10.62%) had a negative perception of solving mathematical problems. In addition, it was observed that female students produced metaphors in the conceptual category of “negative” more than male students, and students with normal development more than gifted students. The metaphors in which students express their negative perceptions towards problem-solving are as follows: a toy that needs to be set up, pepper, sumac, salty ice cream, brain-burning, doing a difficult job, cruelty, a complicated life, solving puzzles, boring, stress, untying the unfolding knot, punishment, chaos, something impossible, and eating apples. Ayvaz Can (2021) examined primary school students' perceptions of solving mathematics problems through metaphors and concluded that a few students perceive solving mathematics problems negatively. Uygun et al. (2016) analyzed how students studying in classroom teaching and primary school mathematics teaching programs perceived the mathematics problem through metaphor. As a result of the research, it was determined that some students studying in both departments had negative thoughts about the problem. Similarly, there are many studies in the literature in which students perceive the mathematics problem as difficult and complex (Arslan & Altun, 2007; Bjälkebring, 2019; Işık & Kar, 2011; Özsoy, 2005; Sezgin Memnun, 2015; Skagerlund et al., 2019; Yazgan, 2007). It can be said that this result obtained from here is similar to the literature.

Some students who participated in the research produced metaphors in their conceptual categories that were developed and required to solve the mathematics problem. Mathematical problem-solving is a process of new acquisitions (NCTM, 2000). Van de Walle, Karp, and BayWilliams (2016) have expressed learning as the result of problem-solving. The result obtained from the study is in line with the field literature. At the same time, this result reflects the change in the role of problems in mathematics teaching and the problem-solving teaching process.

## CONCLUSION

Problem-solving is one of the critical skills that must be developed in providing conceptual learning in mathematics education. Students' perception of mathematical problem-solving affects their problem-solving skills. In this research, students' perceptions of problem-solving were determined through metaphors. There may be various reasons for students' perceptions of problem-solving. The reasons for the perception that mathematics is difficult to solve the problem and the perception of negativity can be investigated. Thus, measures can be taken to address the factors that cause the formation of negative perceptions. It may be suggested to carry out studies at different grade levels or samples to reveal these causes. Besides, the reasons for the perceptions of gifted and typically developing students towards mathematical problem-solving can be examined. In addition, research can be conducted in which the mathematical problem-solving skills and perceptions of different groups of students are discussed together and comparatively.

This research data is limited to the data obtained from 206 students studying at different grade levels, 106 gifted and 100 typically developing. The fact that gifted and normally developing students are at different grade levels is another limitation of this research data.



## DECLARATIONS

- Author Contribution : ZE: Conceptualization, Data collection and editing process, Analysis, Writing – original draft, Writing – review & editing.  
PDA: Writing – original draft, data collection, and editing process, analysis, Writing – review & editing.
- Conflict of Interest : The authors declare no conflict of interest.
- Additional Information : Additional information is available for this paper.

## REFERENCES

- Allen, B., & Shiu, C. (1997). Learning mathematics is like...'-views of tutors and students beginning a distance taught undergraduate course. *Proceedings of the British Society for Research into Learning Mathematics*, 8-11.
- Altun, S. (2015). The effect of cooperative learning on students' achievement and views on the science and technology course. *International Electronic Journal of Elementary Education*, 7(3), 451-468. <https://www.iejee.com/index.php/IEJEE/article/view/91/89>
- Anılan, B. (2017). Fen bilimleri öğretmen adaylarının kimya kavramına ilişkinin metaforik algıları. *Eğitimde Nitel Araştırmalar Dergisi*, 5(2), 7-27. <https://dergipark.org.tr/en/download/article-file/366466>
- Arıkan, E. E. (2014). Ortaokul öğrencilerinin matematik problemleri çözme-kurma becerilerinin ve problem kurma ile ilgili metaforik düşüncelerinin incelenmesi. [Doctoral dissertation, Yıldız Teknik University]. <http://localhost:6060/xmlui/handle/1/1824>
- Arslan, Ç., & Altun, M. (2007). Learning to solve non-routine mathematical problems. *Elementary Education Online*, 6(1), 50-61. <https://ilkogretim-online.org/fulltext/218-1596621184.pdf?1692178180>
- Arslan, M. M., & Bayrakci, M. (2006). Metaforik düşünme ve öğrenme yaklaşımının eğitim-öğretim açısından incelenmesi. *Milli Eğitim*, 35(171), 100-108.
- Ayvaz Can, A. (2021). İlkokul dördüncü sınıf öğrencilerinin matematik problemi çözmeye ilişkin algılarının metaforlar yoluyla analizi. *Uşak Üniversitesi Eğitim Araştırmaları Dergisi*, 7(1), 103-118. <https://doi.org/10.29065/usakead.882143>
- Balci, F. A. (2011). Metaphorical images of school: School perceptions of primary education supervisors. *Eurasian Journal of Educational Research (EJER)*, (44), 51-70.
- Baykul, Y. (2009). *İlköğretimde matematik öğretimi 6-8. sınıflar*. Ankara: Pegem Akademi.
- Bjalkebring, P. (2019). Math anxiety at the university: What forms of teaching and learning statistics in higher education can help students with math anxiety?. *Frontiers in Education*, 4. <https://doi.org/10.3389/educ.2019.00030>
- Cassel, D., & Vincent, D. (2011). Metaphors reveal preservice elementary teachers' views of mathematics and science teaching. *School Science and Mathematics*, 111(7), 319- 324. <https://doi.org/10.1111/j.1949-8594.2011.00094.x>
- Choi, H. H., & Kim, M. J. (2016). The potential of reasoning methods as a teaching strategy supporting students' creative thinking in architectural design. *ArchNet-IJAR: International Journal of Architectural Research*, 10(3), 6.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.





- Dayı, E., Acikgoz, G., & Elci, A., (2020). Metaphorical perceptions of preservice teachers of fine arts education towards students with special needs (The case of Gazi University). *Ankara University Faculty of Educational Sciences Journal of Special Education*, 21(1), 95-122. <https://doi.org/10.21565/ozelegitimdergisi.616520>
- Denzin, N. K., & Lincoln, Y. S. (2008). Introduction: The discipline and practice of qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (pp. 1–43). Sage Publications, Inc.
- Dickmeyer, N. (1989). Metaphor, model, and theory in education research. *Teachers College Record*, 91(2), 151-160. <https://doi.org/10.1177/016146818909100204>
- Edwards, S. M. (2001). The technology paradox: Efficiency versus creativity. *Creativity Research Journal*, 13(2), 221-228. [https://doi.org/10.1207/S15326934CRJ1302\\_9](https://doi.org/10.1207/S15326934CRJ1302_9)
- Eker, C. & Sıcak, A. (2016). Sınıf öğretmeni adaylarının birleştirilmiş sınıflı öğretime ilişkin. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, 1(37), 133-153. <https://dergipark.org.tr/pub/maeuefd/issue/19410/206389>
- Eraslan, L. (2011). Sosyolojikmetaforlar. *Akademikbakışdergisi*, 27(1), 1-22.
- Feist, G. J., & Barron, F. X. (2003). Predicting creativity from early to late adulthood: Intellect, potential, and personality. *Journal of Research in Personality*, 37(2), 62-88. [https://doi.org/10.1016/S0092-6566\(02\)00536-6](https://doi.org/10.1016/S0092-6566(02)00536-6)
- Fitzpatrick, C. C. (1994). *Adolescent mathematical problem-solving: The role of mathematics knowledge, gender, metacognition, strategies, and beliefs*. Columbia University.
- Gagné, F. (2004) Transforming gifts into talents: the DMGT as a developmental theory. *High Ability Studies*, 15(2), 119-147, <https://doi.org/10.1080/1359813042000314682>
- Gail, M. (1996). Problem solving about problem solving: framing a research agenda. *Proceedings of the Annual National Educational Computing Conference*, Minnesota, 17, 255-261. <https://files.eric.ed.gov/fulltext/ED398890.pdf>
- Gür, H., & Korkmaz, E. (2003). İlköğretim 7. Sınıf öğrencilerinin problem ortaya atma becerilerinin belirlenmesi. *Matematikçiler Derneği Bilim Köşesi*. [www.matder.org.tr](http://www.matder.org.tr)
- Işık, C., Kar, T., Yalçın, T., & Zehir, K. (2011). Prospective teachers' skills in problem posing with regard to different problem posing models. *Procedia-Social and Behavioral Sciences*, 15, 485-489. <https://doi.org/10.1016/j.sbspro.2011.03.127>
- Kaçer, T. (2021). Tom stoppard's science plays: Metaphor and experiment. *Świat i Słowo*, 36(1), 77-89. <https://doi.org/10.5604/01.3001.0014.7963>
- Kiliç, D., & samancı, O. (2005). İlköğretim okullarında okutulan sosyal bilgiler dersinde problem çözme yönteminin kullanılışı. *Atatürk Üniversitesi Kazım Karabekir Eğitim Fakültesi Dergisi*, 11, 100-112. <https://dergipark.org.tr/en/download/article-file/31421>
- Krulik, S., & Reys, R. E. (1980). *Problem solving in school mathematics: 1980 yearbook*. National council of teachers of mathematics.
- Krulik, S., & Rudnick, J. A. (1985). Activities: Developing Problem-Solving Skills. *The Mathematics Teacher*, 78(9), 685-698. <https://doi.org/10.5951/MT.78.9.0685>
- Lakatos, I. (1976). *Falsification and the methodology of scientific research programmes* (pp. 205-259). Springer Netherlands.
- Lakoff, G. & Johnson, M. (2005). Metaforlar Hayat, Anlamve Dil. (Çev: G. Y. Demir). *İstanbul: Paradigma*

- Latterell, C. M., & Wilson, J. L. (2016). Math is like a lion hunting a sleeping gazelle: Preservice elementary teachers' metaphors of mathematics. *European Journal of Science and Mathematics Education*, 4(3), 283-292. <https://doi.org/10.30935/scimath/9470>
- Lesh, R., & Zawojewski, J. (2007). Problem solving and modeling. *Second Handbook of Research on Teaching and Learning*, 2, 763-804.
- Levine, P. M. (2005). Metaphors and images of classrooms. *Kappa Delta Pi Record*, 41(4), 172-175.
- Mayer, R. E. (2002). Invited reaction: Cultivating problem-solving skills through problem-based approaches to professional development. *Human Resource Development Quarterly*, 13(3), 263-269. <https://doi.org/10.1002/hrdq.1030>
- McMillan, J. H., & Schumacher, S. (2010). Research in Education: Evidence-Based Inquiry, MyEducationLab Series. Pearson.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.
- Ministry of National Education [MoNE]. (2018). Mathematics curriculum (primary and secondary school grades 1, 2, 3, 4, 5, 6, 7 and 8). Ankara: MoNE, by the Ministry of National Education in January 2017.
- Ministry of National Education [MoNE] (2019). Bilsem yönergesi [Science and art center directive. **Directive**]. *Tebliğler Dergisi, Ankara*. 390-427.
- National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics*, Reston, VA: NCTM.
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, Va.: NCTM.
- Newell, A., & Simon, H. A. (1972). *Human problem solving* (Vol. 104, No. 9). Englewood Cliffs, NJ: Prentice-hall.
- Nikitina, L., & Furuoka, F. (2008). " A Language Teacher is Like...": Examining Malaysian Students' Perceptions of Language Teachers through Metaphor Analysis. *Online Submission*, 5(2), 192-205.
- Oğuz, A. (2009). Öğretmen Adaylarına Göre Ortaöğretim Öğretmenlerini Temsil Eden Metaforlar. Milli Eğitim, 38(182), 36-56.**
- Orton, A., & Wain, G. (1994). *Issues in Teaching Mathematics*. New York: Cassell.
- Özsoy, G. (2005). Problem çözme becerisi ile matematik **başarısı arasındaki ilişki**. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, 25(3), 179-190. <https://dergipark.org.tr/en/pub/gefad/issue/6755/90832>
- Palmquist, R. A. (2001). Cognitive style and **users' metaphors for the web: An exploratory study**. *The Journal of Academic Librarianship*, 27(1), 24-32. [https://doi.org/10.1016/S0099-1333\(00\)00205-6](https://doi.org/10.1016/S0099-1333(00)00205-6)
- Pesen, C. (2003). **Matematik öğretimi**. Ankara: Nobel Yayın Dağıtım
- Polya, G. (2004). *How to solve it: A new aspect of mathematical method* (No. 246). Princeton university press.
- Polya, G. (2006). From the 1950s: Mathematics as a subject for learning plausible reasoning. *The Mathematics Teacher*, 100(5), 36-39. <https://doi.org/10.5951/MT.100.5.0036>
- Posamentier, A. S., & Krulik, S. (2016). *Strategy games to enhance problem-solving ability in mathematics* (Vol. 5). World Scientific.
- Renzulli, J. S. (1978). What makes giftedness? Reexamining a definition. *Phi Delta Kappan*, 60(3), 180. <https://doi.org/10.1177/003172171109200821>



- Rubinstein, G. (2003). Authoritarianism and its relation to creativity: A comparative study among students of design, behavioral sciences and law. *Personality and Individual Differences*, 34(4), 695-705. [https://doi.org/10.1016/S0191-8869\(02\)00055-7](https://doi.org/10.1016/S0191-8869(02)00055-7)
- Saban, A. (2004). **Prospective classroom teachers' metaphorical images of selves and comparing them to those they have of their elementary and cooperating teachers.** *International Journal of Educational Development*, 24(6), 617-635. <https://doi.org/10.1016/j.ijedudev.2004.03.003>
- Saka, E., & Durmuş, M. (2021). **Sınıf öğretmeni adaylarının matematiksel problem çözmeye yönelik inançlarının ve metaforik algılarının incelenmesi.** *Ekev Akademi Dergisi*, 25(85), 129-150. <https://dergipark.org.tr/en/download/article-file/2568258>
- Schinck, A. G., Neale, H. W., Pugalee, D. K., & Cifarelli, V. V. (2008). Using metaphors to unpack student beliefs about mathematics. *School Science and Mathematics*, 108(7), 326-333. <https://doi.org/10.1111/j.1949-8594.2008.tb17845.x>
- Schoenfeld, A. H. (2014). *Mathematical problem solving*. Elsevier.
- Senemoğlu, N. (2005). *Gelişim Öğrenmeve Öğretim Kuramdan Uygulamaya*. Ankara: Gazi Kitabevi.**
- Sezgin Memnun, D. (2015). Secondary school students' metaphors about mathematical problem and change of metaphors according to grade levels. *Necatibey Faculty of Education Electronic Journal of Science & Mathematics Education*, 9(1), 351-374. [http://www.nef.balikesir.edu.tr/~dergi/makaleler/yayinda/18/EFMED\\_MTE215.pdf](http://www.nef.balikesir.edu.tr/~dergi/makaleler/yayinda/18/EFMED_MTE215.pdf)
- Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *Zdm*, 3(29), 75-80. <https://doi.org/10.1007/s11858-997-0003-x>
- Silverman, K. (2000). *World spectators*. Stanford University Press.
- Skagerlund, K., Östergren, R., Västfjäll, D., & Träff, U. (2019). How does mathematics anxiety impair mathematical abilities? Investigating the link between math anxiety, working memory, and number processing. *PLoS One*, 14(1), e0211283. <https://doi.org/10.1371/journal.pone.0211283>
- Solomon, C., & Grimley, M. (2011). Metaphors used by year 5 and 6 children to depict their beliefs about maths. Paper presented at the 34th annual conference of the Mathematics Education Research Group of Australasia and the Australian Association of Mathematics Teachers, Alice Springs.
- Sterenberg, G. (2008). *Investigating teachers' images of mathematics*. Journal of Mathematics Teacher Education**, 11, 89-105. <https://doi.org/10.1007/s10857-007-9062-8>
- Taylor, W. (1984). *Metaphors of Education*, Heineman Educational Books Ltd, London.
- Ülgen, G. (2001). *Kavramgeliştirme: Kuramlarveuygulamalar (3. Baskı)* Ankara: Pegem-A Yayıncılık.**
- Uygun, T., Gökkurt, B., & Usta, N. (2016). **Üniversite öğrencilerinin matematik problemine ilişkin algılarının metafor yoluyla analiz edilmesi.** *Bartın University Journal of Faculty of Education*, 5(2), 536-556. <https://doi.org/10.14686/buefad.v5i2.5000187677>
- Uzun, A., Özdemir, B. G., Çetinöz, E. E., & Şahan, G. (2022). **Hafif düzeyde zihinsel yetersizliği olan bir öğrenciye sesli düşünme yöntemi ile çıkarma işleminin öğretimi.** *EĞİTİM VE BİLİM*, 47(210), 321-356. <https://doi.org/10.15390/EB.2022.10491>
- Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2016). *Elementary and middle school mathematics*. London: Pearson Education UK.
- Vordermann, C., Porkess, R., Budd, C., Dunne, R., & Rahman-Hart, P. (2011). *A world-class mathematics education for all our young people*. London: The Conservative Party.
- Winner, E. (1997). Giftedness vs. creativity in the visual arts. *Gifted and Talented International*, 12(1), 18-26. <https://doi.org/10.1080/15332276.1997.11672861>

- Yazgan, Y. (2007). Dördüncü ve beşinci sınıf öğrencilerinin rutin olmayan problem çözme stratejileriyle ilgili gözlemler. *İlköğretim Online*, 6(2), 249-263. <https://dergipark.org.tr/en/download/article-file/91012>
- Yee, S. P. (2017). Students' and teachers' conceptual metaphors for mathematical problem solving. *School Science and Mathematics*, 117(3-4), 146-157. <https://doi.org/10.1111/ssm.12217>
- Yee, S. P., & Bostic, J. D. (2014). Developing a contextualization of students' mathematical problem solving. *The Journal of Mathematical Behavior*, 36, 1-19. <https://doi.org/10.1016/j.jmathb.2014.08.002>
- Yetim Karaca, S. & Ada, S. (2018). Öğrencilerin Matematik Dersineve Matematik Öğretmenine Yönelik Algılarının Metaforlar Yardımıyla Belirlenmesi. *Kastamonu Eğitim Dergisi*, 26(3), 789-800. <https://dx.doi.org/10.24106/kefdergi.413327>
- Yıldırım, A., Hacıhasanoğlu, R., Karakurt, P., & Türkleş, S. (2011). Problem solving skills and influential factors in high school students. *Journal of Human Sciences*, 8(1), 905-921. <https://www.j-humansciences.com/ojs/index.php/JHS/article/view/1134>
- Yıldırım, A., & Şimşek, H. (2011). Sosyal bilimlerde nitel araştırma yöntemleri. Seçkin Yayıncılık, Ankara, 446.
- Yıldızlar, M. (2012). Öğretmen adaylarının öğrenme stratejileri üzerine bir çalışma. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 42(42), 430-440. <http://efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/342-published.pdf>
- Zheng, H. B., & Song, W. J. (2010). Metaphor analysis in the educational discourse: A critical review. *US-China Foreign Language*, 8(9), 42-49. <https://files.eric.ed.gov/fulltext/ED514704.pdf>

