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Metaphorıcal Perceptıons of Geometrıcal Concepts by Secondary School Students Identıfıed As Gifted and Identıfıed As Non-Gıfted*

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ABSTRACT

The aim of this study is to analyze the metaphorical perceptions of geometrical concepts by secondary school students who are identified as gifted and non-gifted. The study was conducted with 160 students who were identified as gifted and 85 students who were identified as non-gifted, for a total of 245 students in 2014- 2015 academic year. To determine the perceptions of the participants regarding the geometry concepts, they were asked to complete the sentences such as; "Geometry is like…/similar to…, because...". The participants not only developed a metaphor, but also explained why they used this metaphor. The content analysis was used to interpret and analyze the data.According to the findings, the students produced a total of 142 valid metaphors for the concept of geometry. These metaphors are grouped under 10 different conceptual categories in terms of their common features. Conceptual categories did not demonstrate significant differences between the gifted students and the non-gifted students. The students identified geometry mainly as an infinite and indispensable element, and a course which can reflect various aspects of life with the natural qualities. They have shown to believe this course is necessary and important. Metaphors can be used as a powerful research tool for students to understand their personal perceptions regarding geometry.

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Keywords:
Geometry Education, Gifted Student, Metaphor

Introduction

In science, art, architecture, and engineering, -in short, in every elements people create- geometry makes itself felt and is intertwined with daily life (Van De Walle, 2001). Geometry is a regular way to identify and represent the geometric world we inherited. Understanding geometry is basically the development of a spatial sense which is an intiutive (intrinsic) sense for the environment we live in and for the objects in it (Hoover, 1996). Geometry provides opportunities to students to activate their minds, to do mind exercises, and to develop their skills of problem solving, comparison, generalization and summarization. In general, geometry is an important tool in which students could give the meaning to the environment they live in. (NCTM, 2000; Napitupulu, 2001) In science, art, architecture, and engineering, -in short, in every elements people create- geometry makes itself felt and is intertwined with daily life (Van De Walle, 2001).

Geometry offers a natural environment for the development of students' inferring and proving skills. Students can solve problems by means of geometry and can establish a link between life and mathematics (Duatepe, 2000). The process of learning geometry starts with children's experiences of seeing, knowing and understanding the physical world around them and continues with high level geometrical thinking which

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develops within an inductive or deductive system (Ubuz, 1999). The base of understanding geometry is considered to be the development of a special sense. The children who are comfortable with spatial relationships and who have a grasp of geometry concepts are also ready to learn more advanced mathematical topics. The experiences gained in the classroom on the geometric relationships develop the spatial senses of the children (Hoover, 1996). While geometry has a great importance in terms of life and mathematics, unfortunately many studies have shown that students' comprehension of geometry was not at the expected and the desired levels (Battista and Clements, 1988; Clements and Battissa, 1992; Carroll, 1998; Meng Lian and Idris, 2009).

When the tests conducted in Turkey and abroad are analyzed in particular, similar conclusions are reached. For example, some foreign exam results, such as TIMSS (Trends in International Mathematics and Science Studies Examination) and PISA (Program for International Student Assessment) were examined, the success level of geometry has proven lower in Turkey. In these international tests, geometry has lower averages according to its subdimensions, algebra, numbers, data and probabilistic subdimensions (TIMSS, 2007). In the MOE (Ministry of Education) data: According to the TIMSS 1999 results, Turkey came 31st in mathematics out of 38 countries. While the international average is 487 in math, Turkey's average is 429. The averages compared to the sub-dimensions are as follows: Data representation, analysis and probability is 446; measuring is 436; algebra is 432; understanding the numbers and fractions is 430; geometry is 428. It means that our weakest field is geometry. International exams such as PISA and TIMSS show that our students find difficult to understand geometry in our country. That these failures have cognitive and affective resources is an undeniable truth.

The conducted studies have indicated some factors such as; the fact that students' affective characteristics such as attitude and anxiety influence learning and ignoring of their Van Hiele geometric thinking levels (Olkun and Aydogdu, 2003; Fidan and Türnüklü, 2010). According to Van Hiele theory, as in any mathematical operation or concept, geometrical understanding also passes through certain stages. According to Van Hiele couple, the reason why students fail in geometry is the fact that the level of geometry education is above the level of students' understanding. They found that students were taught in inference level and weren't taught in other levels. Therefore, they argued that students must be taught geometrical concepts from the first years of primary education.

1. Visual Level: At this level, students are interested in the geometrical images of the objects. They don't know the geometrical features of them.

2. Analysis Level: Students distinguish the characteristics of the shapes at this level and can tell about these features. However, they cannot associate them with each other.

3. Pre-Logical Inference Level: At this level, definitions and axioms are meaningful for the students, but logical inferences are not yet understood. Students begin to see the connections of the shapes with each other.

4. Logical Inference Level: While doing geometrical proofs, students can use theorems, axioms and definitions. They can determine the conditions of necessity and sufficiency and can use them to prove or to infer the results. Utilizing from the previously proven theorems and axioms, they can prove other theorems with the deductive method. This period corresponds to the student's high school years.

5. Top-Level: Student at this level understands geometry like a mathematician. He can infer the axioms, definitions, and theorems of Euclidean geometry in non-Euclidean geometry, and can make applications. He can recognize the differences, similarities and relationships of axiomatic systems.

According to Van Hiele, these levels are in a hierarchical order. It cannot be passed to the next level before the current level is passed. Moreover, this development is entirely depended on the given training. Unless an appropriate training was given, 3rd, 4th and 5th levels are almost impossible to be reached. Passing from one level to the other depends on the quality of the education and the subject of training rather than the age and the maturity (Findell at.all, 2001).

Paying attention to the Van Hiele levels, understanding level of students can be captured. In addition, the affective components that have an important role in success should not be ignored. In this context, Bloom (1998) suggests that students' affective characteristics such as attitude and anxiety influence their success and learning. In many studies, it was found that there was a positive relationship between students' successes in

math and geometry and their attitudes (MA and Kishor, 1997; Mogari, 1999; Yee, 2010; Senturk, 2010; Yildiz and Turanli, 2010).

In this respect, the perceptions and perspectives of the students on geometry, in other words, determining their affective characteristics related to geometry, will positively affect educational applications prepared for teachers and students. Metaphors have an important function to reveal the affective characteristics of students. Metaphor is expressed as the “figure of speech” in Turkish and is defined as: "use of a word or a concept in a way other than its meaning aside from its acceptable usage" (TDK-Turkish Language Association, 2011). A methapor, which is a linguistic tool connecting two objects or concepts with each other, is considered as a symbolic language structure that links two different ideas or concepts in order to make a transition or comparison from one life area to another. Metaphors appear in daily conversations as nouns, verbs or qualifiers (Palmquist, 2001). It is also an expressing process of a meaning structure with another meaning structure according to Kovecses (2002). A metaphor is a phrase defined as using two semantic structures which have a combination of similarity in terms of meaning. One of these two structures is in a direct structure and the other is in indirect structure and they form a metaphor (Steen, 2007). Metaphor is also described as "correlating with the abstract concepts and the recognized concrete things" (Saban, 2004). Metaphors are formed with the use of creative ways in order to create new meanings. This creative thinking is composed of in all areas of life, and therefore metaphors can be used in a wide range (Radman, 1997). Metaphors are a mental phenomenon and usually have a structure expressed in a verbal form. However, they can be expressed in multiple formats. People use them in a family or work environment, while communicating with each other, expressing positive statements (e.g. their happiness), showing their interests, and approving something, as well as expressing negative statements. Thus, metaphors, are often used in daily life within the context of how people understand their own selves and others (Zanotto, Cameron and Cavalcanti, 2008).

While expressing an opinion, people have to transform it into such a structure which is understandable by people (Pratte, 1981). In order to be able to understand and explain a concept, using a more concrete and acceptable object would be more effective. Two basic principles of education are to go from the known to the unknown and to go from abstract to concrete. Metaphors use concrete examples to describe abstract principles. The physical reality which is known and seen will be used to identify the spiritual reality which is unknown and unseen. Metaphors, described as "...a powerful mental mapping and modeling mechanism towards individuals’ understanding and configuring their worlds" (Arslan and Bayrakci, 2006), intensively captivates the attention of today's educators. In education, especially, metaphors are used to describe and reveal assumptions related to some concepts. In this context, certain studies on the following concepts were conducted: teacher (Pektas and Kilan, 2009; Ben-Peretz, Mendelson, and Kron 2003; Michael, 2009; Saban, 2004; Celikten, 2006; Oxford, Tomlinson, Barcelos, Harrington, Lavine, Saleh et al 1998; Lasley, 1994; Clarken, 1997); teaching and learning (Font, Bolite and Acevedo, 2010; Saban, Kocbeker and Saban, 2007; Levine, 2005; Guerrero and Villamil, 2002; Martinez, Sauleda and Huber, 2001); education (Tasdemir and Tasdemir, 2011; Massengill-Shaw and Mahlios, 2008; Carter and Pitcher, 2010; Massengill, Mahlios, and Barry, 2005, Goldstein, 2005; Price, 2002; Bullough, 1991); school (Saban, 2008; Aydogdu, 2008; Engin-Demir, C. 2007; Inbar, 1996; Hardcastle, Yamamoto, Parkay and Chan, 1985); learning (Elmholdt, 2003); class management (Akar and Yildirim, 2009); professional development (Bullough and Stokes 1994; Bullough, 1994); and program development (Semerci, 2007).

In this study, the metaphors produced by students, identified as gifted and non- gifted, on the concept of geometry will be analyzed. A gifted child is a child who needs services or activities which are not provided by the school in specific academic fields in order to improve his/her intelligence, creativity, art and leadership skills. (Ministry of Education, Directive of Science and Arts Centers). Gifted children are differentiated from their peers by certain characteristics including high skill, motivation and creativity levels (Cutts and Moseley, 2004).

In this study, the metaphors that are produced by the students identified as gifted and non-gifted are crucial since they reveal the gifted students' creativity and perception. Creativity was identified by various researchers as an important skill to be found in gifted individuals (Torrance, 1974; Chamberlin and Moon, 2005; Sriraman, 2005). Like in many countries, mathematics and, related to that, geometry courses have always preserved the characteristic of being difficult. Today, many countries have been making serious efforts in their education programs to eliminate this image. As a result of these efforts, the success rate in these courses has

increased and the interest in the courses has risen likewise. The increase in interest has also changed the perceptions towards mathematics, geometry, and math courses where these two subjects are taught. Today, one of the studies conducted to reveal how mathematics was perceived is the perception studies related to math and relevant subjects in mathematics (math teacher, math tools, sub-branches of mathematics, mathematics exams etc.). Metaphors are the types of perception used for this purpose. Since mathematics and geometry are considered as challenging subjects, many people think that those who succeed on these subjects are smart or hardworking. Those students in the community who have superior cognitive characteristics are more successful than their peers, and their perceptions towards geometry are significant components in order to describe the affective dimension of their achievement.

Gifted students are the individuals who have talent above average, have creative and critical thinking skills, have advanced problem solving skills, have stronger reasoning skills than their peers, demonstrate problem solving and planning skills (Sak, 2010; Gallagher, 2008; Gagné, 2004; Renzulli, 1999). In addition, these students can be defined as the individuals, who have creative thinking skills, ask a lot of questions, have a high imagination skill (Davasligil, 1990), think about many ways to reach a goal, give answers to the unexpected questions expertly, have original ideas, and keep the knowledge they learned in mind.

Since metaphors are defined one of the most important perception tools (Ben-Peretz, Mendelson and Kron, 2003), how gifted students perceive the concept of geometry with metaphors are wondered because of their characteristics which separate gifted children than others, and the perception differences between gifted and non-gifted are tried to be revealed with this study. Evaluation of the perceptions of the children identified as gifted and as non-gifted will contribute to the development of students and will provide a more professional approach. The study investigated how the perceptions of secondary school students are formed through the ways by which students, identified as gifted and non-gifted, understand geometry through metaphors. By analyzing the metaphors produced by two groups of students in detail regarding geometry, the study found that students' creativity levels could be determined by the metaphors they produced.

Review of Literature

Indeed, studies that mention metaphors are quite common in the national and international educational literatures. For example, in a study he conducted with 254 educators and 409 students, Inbar (1996) collected 7042 metaphors about the concepts of student, teacher, principal and school. Conducting a study on 120 prospective teachers, Gultekin (2013) analyzed the metaphors that prospective Primary school teachers used to assign meanings to the concept of Educational Program. Silman and Simsek (2006) examined the metaphors used by 13 teachers and 4 administrators from Turkey and 10 teachers and 1 principal from the United States, for a total of 28 educators, in order to describe the concepts of "school", "administrator", "parent" and "centralized management". Cerit (2006) conducted a study on the perceptions of 600 fifth grade students and their 203 classroom teachers and 51 administrators related to the concept of school through metaphors. Saban (2004) analyzed the metaphors of 151 freshmen prospective classroom teachers (74 of them were studying in daytime education and 77 of them were studying in evening education) about the concept of teacher. Bozlk (2002) also analyzed the metaphors produced by 49 freshmen who were taking education class about how they perceived themselves as a student in four different times of the semester (the first week of the class, midterm exam time, the last week of the course and the following period).

Sahin, in his study in 2013, analyzed the metaphorical perceptions of prospective teachers about the concepts of "Math Teacher", "Mathematics" and "Mathematics course". In the study, the concept of “Mathematics Teacher” was associated with the metaphors of "knowledgeable" and "authoritarian", while the concept of “Mathematics" was associated with the metaphors of "intelligence", "tasteful", "necessary", "ability", "tough", and "success". Guner, in his study in 2013, analyzed the metaphors that the 12th graders produced on learning math with a descriptive analysis. He determined the relationship between the high school types and student genders and the metaphors they produced. He discovered the findings that the students studying in Anatolian high schools produced more metaphors about taking pleasure from math than vocational high school students, but the male students and vocational high school students produced more metaphors in all conceptual categories about learning difficulties in mathematics and suffering from learning it than the female students and Anatolian high schools students. Guner, in his other study in 2013, analyzed the metaphors of different prospective branch teachers about mathematics. In the study in which 28 different metaphors were produced, it was found that the majority of teachers chose the finding of “mathematics is the life itself”. Sengul,

Katranci and Cantimer (2014) studied the metaphors about perceptions of secondary school students regarding the concept of 'mathematics teacher' and analyzed if these metaphors differed from their grade levels and genders. As a result, they concluded that the secondary school students perceived their math teachers as individuals who were guides and counselors knowledgeable, and taught math in entertaining ways. Bahadir and Ozdemir (2012) studied the metaphors on the perceptions of secondary school students for the concept of math. They found from these metaphors that students thought about math as a memorization and calculation tool. Plenty of studies exist in the literature regarding the students identified as gifted and identified as non-gifted. Gunes (2010) made the comparison of leadership skills of gifted and normally developing primary school students. Similarly, there are many studies such as; Leana's (2005) study on administrative functions in gifted and normal children (Tower of London test), and Uyaroglu's (2011) study which analyzed empathy skills and emotional intelligence levels of primary school students and comparative status of gifted students and non-gifted. In addition to these studies, there are many more metaphor studies that revealed the perceptions of gifted students on various issues. These include: Kunt and Kartop's (2013) study on science and arts centers; Mertol, Dogdu and Yilar's (2013) study on social sciences; and Ozsoy's (2014) study on the perceptions of students. In all these aforementioned studies, the diversity of the metaphors developed by the gifted students has been pointed out. Additionally, even though the produced metaphors were the same, the inferences about them showed diversity. The students whose perceptions were determined as opener than their peers by the tests were seen to have willingly participated almost all of the metaphor studies which had been made in different topics and had been focused to understand perceptions. These students have also been found to be more diligent and more successful in producing metaphors compared to their peers who were not identified as gifted.

This study was aimed to determine the metaphorical perceptions of the secondary school students identified as gifted and non-gifted related to the concept of mathematics.

Research Questions

In the framework of these objectives, the answers of the following questions have been sought:

1. What are the metaphors the students have about the concept of mathematics?
2. Under which conceptual categories can these metaphors be grouped in terms of common features?
3. Do the metaphors produced by students identified and not identified as gifted differ from each other?

Methodology

Out of qualitative research methods, phenomenography was used in the study. In this method, perceptions and events are revealed in their natural environment in a more realistic and a holistic manner (Yıldırım and Simsek, 2005). Emerged in the 1980's, phenomenographic research studies have been considered as a new approach (Akerlind, 2005). During phenomenographic analysis, firstly qualitative difference categories are tried to be identified, then how the participants perceive the concepts and events are revealed, and finally the researcher starts to create categories by comparing the similarities and differences between the participants of the study (Bas & Akturan; 2008) .

Participants

The study has been conducted on a total of 160 students who were on the 6th, 7th and 8th grades in a secondary school in Sariyer, Istanbul and 85 secondary level gifted children who attended the Enderun center for gifted children in Bagcilar, Istanbul, in 2014- 2015 academic year. The number of students' not being equal in the study stemmed from the inconsistency of the number of students who are enrolled in Enderun Science and Arts Center for the gifted and who study in the surveyed school. Enderun Center has 126 students. However, the estimated number of students could not be attained because some of the students were out of town for a competition while the study was conducted.

In Turkey, the most common official application made regarding the education of the gifted is the Science and Arts Centers. According to the Science and Arts centers guidelines, training programs implemented in these centers should be student-centered, interdisciplinary, modular, under the guidence of advisors, appropriate for the individual learning, and supportive for the creativity and problem-solving skills of a student. In Turkey, Science and Arts Centers come at the top of the list of educational institutions for gifted and talented children. There have been many Science and Arts Centers in many provinces of our country

and they have continued their educational activities outside school hours. In this system, while gifted students attend school with their peers, they also continue their education after school or at weekends at the Science and Arts Centers.

The process to determine gifted students who will be admitted to the Science and Arts Centers proceeds within the framework of the diagnostic calendar specified by the Ministry. Students from different grade levels selected by the Ministry are nominated as gifted in the fields of general mental ability, music or arts by their classroom teachers through the e-school system, using the observation forms prepared by the Ministry.

The students who are nominated are taken in a group screening test, which takes place nationwide concurrently on a date determined by the Ministry. According to the test results, the students who pass the minimum score determined by the Ministry are taken into an individual assessment by the certified experts. In individual assessment, the Wechsler Nonverbal (WNV) Aptitude Test is applied to the students.

All of the students who are nominated by classroom teachers in the fields of arts and/or music skills, regardless of their exam results, are taken into the individual assessment in the field of arts and/or music skills by the Province Diagnostic Commission. The list of students prepared according to the results of all three areas is sent to the General Directorate of Ministry of Education Special Education and Guidance Services by the Province Diagnostic Commission. The students who have passed the minimum bar for Turkey determined by the General Directorate for each talent field are enrolled in the Science and Arts Center. (MOE, 2013). The Enderun center for gifted children in Bagcilar is a Science and Arts Center which has been conducting activities for this purpose.

Data Collection

In order to reveal the mental images which the surveyed students have about the concept of geometry, they were asked to complete the sentences such as; "Geometry is like … ; because it is …".

In the studies that metaphor is used as a research tool, the concept of "like" is often used to evoke the link between "the subject of the metaphor" and "the source of the metaphor" more clearly. In this research, using the concept of "because", the participants have been asked to provide a "reason" (or a "logical base") for their own metaphors. These essays the students wrote with their own handwritings have been used as the main data source and a "record" and a "document"in this study.

Data Analysis

Analyzing the metaphors produced by the participants was conducted in the following five stages: (1) coding and eliminating, (2) compiling of sample metaphor image, (3) category development (4) ensuring reliability and validity (5) transferring data into the SPSS packaged software for quantitative data analysis.

Stage 1: Coding and eliminating. The study was conducted with 85 students identified as gifted and 160 students identified as non-gifted, in total 245 students. They were asked about their metaphorical perceptions about geometry. 103 of the metaphors were eliminated as they were invalid. Then, a temporary list of metaphors generated by the participants was made in alphabetical order in order to analyze if certain metaphors had been clearly expressed in the writings of students. At this stage, each metaphor submitted by each participant was simply coded (e.g. game, chocolate, horror movie, electricity). The papers which did not contain any metaphor images and were left blank were eliminated, at this stage.

Stage 2: Compiling of sample metaphor image. A total of 142 valid metaphor images were obtained. At this stage, these metaphors were lined up in alphabetical order, again, and the raw data was revised for the second time and then one each sample metaphor expression has been selected from the students' essays representing each metaphor. Thus, with the compilation of metaphor images assumed to present them ideally for each of 142 metaphors, a "metaphor sample list" was created. This list was compiled for two main purposes: (a) to use it as a reference source for the collection under a certain category and (b) to validate the process and comments of data analysis. However, metaphor essays written in students' own handwritings vary from one page to a few sentences. Therefore, in cases where the chosen metaphor word was too long, only the most important aspects of metaphor were cited, maintaining narrative language and own words of the participants. To symbolize the uncited words, sentences or paragraphs, sets of triple dots (...) were used in the expression of metaphor.

Stage 3: Category development. At this stage, the metaphor images generated by the participants were evaluated in terms of their common features related to mathematics. During this process, a "sample metaphor list" was created based on the 142 metaphors and how each metaphor image conceptualizes the study of math. For this purpose, each metaphor image generated by the participants was analyzed in terms of (1) the subject of metaphor (i.e. "Geometry"), (2) the source of metaphor and (3) the relationship between the subject and the source of the metaphor. Then, each image was associated with a certain theme in terms of the perspective for math (e.g. "maze", "cake", "nail polish", "dessert") and a total of 10 different conceptual categories were created.

Stage 4: Ensuring reliability and validity. Validity and reliability are the two most important criteria used to ensure (or to increase) the credibility of the study results. "Reporting the collected data in detail and the researcher's explanation of how to get the results are among the important criteria of validity in a qualitative research study." (Yildirim and Simsek, 2005). In this particular study, two major operations were carried out to ensure the validity of research results: (1) Data analysis process (how 10 conceptual categories were reached) was described in detail. (2) In the study, best version sample metaphor images of each of the 142 obtained metaphors were compiled and all of the metaphor images were placed in the findings section. To ensure the reliability of the study, an expert was consulted in order to confirm whether the obtained metaphor images given under 10 conceptual categories represented an aforesaid conceptual category. For this purpose, the two lists were given to a math teacher and a faculty member: (a) the list of 142 sample metaphor images in the alphabetical order, and (b) the list containing of the names and features of 10 conceptual categories. The experts were asked to match these two lists with the sample metaphor images and 10 conceptual categories (not excluding any metaphor images). Then, the matches made by the experts were compared with the researcher's own categories. All metaphors were analyzed and their justifications were taken into account and grouped under 10 conceptual categories. Metaphors that could not be associated with any categories were grouped under "other" category. In comparison, determining the numbers of consensus and disagreement, the reliability of the study has been calculated by using the formula of Miles and Huberman (1994) formula (Reliability = consensus + disagreement). In qualitative studies, when the accordance between experts and researches is at the level of 90% and over, it means that the reliability is at the desired level. At the reliability study which is made specifically for this research, 94% of compromise (reliability) has been provided. The expert who was consulted has associated eight metaphors (puzzle, hourglass, eraser, world, plant, mirror, butterfly, song) with a different category within the reliability analysis. In this case, reliability was calculated as = 134/134 + 8 = 0.94.

Stage 5: Transferring data into the SPSS packaged software, for quantitative data analysis. After determining 142 metaphors and developing 9 conceptual categories produced by these metaphors, all data was transferred into the SPSS statistical package. After this procedure, first of all, the number of participants (f) representing 142 metaphors and 9 categories and its percentage (%) were calculated. The metaphors (f) produced by the students identified as gifted and non- gifted and their percentages (%) were calculated separately. Each percentage is the percentage that was specified in the category.

Results

In this section, findings obtained about metaphors that surveyed students produced in relation to the concept of geometry were first presented in a table in general, then categories generated from metaphors were presented in tables and comments of students were cited. The results obtained in the metaphors are shown in Table 1.

All metaphors were analyzed and their justifications were taken into account and then they were grouped under 10 conceptual categories. Metaphors that could be associated with any categories were grouped under the "other" category. The study was conducted on 85 students who were identified as gifted and 160 students identified as non-gifted, and in total 245 students were asked about their metaphorical perceptions of geometry. 103 metaphors out of 245 metaphors (42%) have been eliminated as invalid metaphors. 86 of 103 invalid metaphors (83.45%) were produced by the students who were not identified as gifted, and 17 of them (16.5%) were produced by students identified as gifted. The 142 metaphors produced by students regarding geometry are shown in Table 1. The metaphors indicated by * mark in the table belong to the students identified as gifted. Some metaphors were written twice. The reason is that students have expressed the same

metaphor as a metaphor, but the contents and their categorized classes were different, so, even these are stated with the same metaphor, they are placed in the general table because of their different meanings.

Table 1. Metaphors assigned a meaning to the concept of geometry by students

No	Metaphor	No	Metaphor	No	Metaphor	No	Metaphor
1	Adana kebab*	37	Enjoyable ball	73	Money in penny box*	109	Eraser
2	Tree*	38	Enjoyable tree	74	Bird*	110	Eraser
3	Alphabet	39	An enjoyable concept*	75	Cube	111	An endless rope*
4	Mirror*	40	Apple counting*	76	Maze	112	Question
5	Garden	41	Best friend*	77	Maze*	113	Question*
6	Baklava	42	Home*	78	Tyre	114	Water*
7	Tape*	43	Universe*	79	Amusement park*	115	Surprise egg
8	Brain*	44	Geometry*	80	Adventurous road*	116	Song
9	A wise closet*	45	Planet	81	Cave	117	Sugar*
10	Computer	46	Shadow	82	Model	118	Shape
11	Building*	47	Rose and its thorn*	83	Supermarket	119	Shapes*
12	A piece	48	Sun*	84	Fruit nappy	120	Train
13	Plant*	49	Map	85	Fruit cake	121	Brick
14	Script on a blank paper*	50	Map*	86	Microphone*	122	Tunnel
15	Chamelon	51	Weather	87	Microscope*	123	Flying bird*
16	Puzzle *	52	Dream*	88	Nail polish	124	Mechanical pencil*
17	Ruler	53	Life	89	Arrow	125	Outer space*
18	Object	54	Life*	90	Forest	126	Space*
19	Fountain*	55	Animal	91	Game	127	Body
20	Environment	56	Treasure chest*	92	Game*	128	Body*
21	Flower*	57	Gift*	93	Play dough	129	Jigsaw puzzle*
22	Chocolate cake	58	Everything*	94	Toy	130	Jigsaw puzzle
23	Very fun*	59	People*	95	Daisy	131	Life organ*
24	Notebook	60	Thread*	96	Cake	132	Script*
25	Notebook*	61	Algorithm	97	Cake ingredients	133	Food
26	Lesson	62	Algorithm box	98	Cake*	134	Food*
27	Nature	63	Pen	99	Bargain	135	Gravity*
28	Closet*	64	Pen*	100	Compasses*	136	Indestructible
29	Domino man	65	Truck	101	Problem	137	None
30	Ice cream	66	Mixed fruit juice	102	Problem*	138	Road
31	Pal and friend*	67	Butterfly	103	Puff cake	139	Dice
32	Four operations*	68	Book	104	Strand	140	Mind game*
33	A steady figure*	69	Book*	105	Ivy	141	Mind fuel*
34	Knot	70	Race*	106	Number	142	Chain
35	World	71	Bucket*	107	Numbers*		
36	World*	72	Hourglass*	108	Love*		

As shown in Table 1, a total of 142 metaphors produced relating to the concept of geometry. The metaphors marked with "*" belong to the students identified as gifted. Some of these metaphors (shape f = 6, water f = 3, game f = 9, operation f = 3 ...) were indicated by multiple students. When the metaphors produced by students were carefully examined, ıt was found that the metaphors mostly correlated geometry with non-living things.

The most important point in separating obtained metaphors into the conceptual categories was the source of metaphor and the category under which the thoughts attributed from the metaphor's source to its subject were listed. For example; in the metaphor of "Geometry is like space; because it is infinite", "space" is the source and "infinity" is the thought which is attributed from its source to its topic (geometry). In this respect, this metaphor is considered to be related to the infinity of geometry. As indicated in this example, all metaphors obtained were analyzed and grouped under nine conceptual categories considering their close justifications. Metaphors that could not be associated with any categories were grouped under the"other" category.

Fun side of Geometry

18 of participants (12.08) were found to produce metaphors emphasized the fun side of geometry.

Table 1: Category 1: Fun side of geometry

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Very funny car	1	-	1
Funny tree	-	1	1
Funny concept	-	1	1
Funny ball	-	1	1
Amusement park*	1	-	1
Game	7	2	9
Play dough	-	1	1
Toy	-	1	1
Surprise egg	-	1	1
Microphone*	1	-	1
	10	8	18

10 different metaphors which focused on the fun side of geometry seemed to be produced. The most frequently used metaphor was determined to be "game". Students identified as gifted and non-gifted were seen to produce similar numbers of metaphors in this category. When the metaphors were analyzed, they were seen to emphasize the fun side of geometry. For example;

Geometry is like a game, because we solve problems as if we play a game.

Geometry is like a very entertaining car*, because we have a fun ride with numbers and shapes.

Geometry is like an amusement park, because, it entertains and makes us think.

Geometry is like a microphone*, because when you shout quietly on it, the sound comes out higher, and in geometry, you do less operations, but the result comes out quickly.

Geometry as a Dessert

9 Participants (6.33%) have been seen to produce metaphors which they describe geometry as a dessert. 7 different metaphors have been identified which they describe Geometry as a dessert. The most frequently used metaphor in this category was determined to be "cake". The non-gifted students produced more metaphors in this category. When the metaphors were analyzed, it was observed that students emphasized geometry as a dessert, because they likened it to the shape of a cake and geometry could be solved easily. For example;

Table 2: Category 2: Geometry as a dessert

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Baklava	-	1	1
Ice cream	-	1	1
Cake*	1	2	3
Puff cake	-	1	1
Sugar*	1	-	1
Fruit Cake	-	1	1
Chocolate Cake	-	1	1
	2	7	9

Geometry is similar to a cake*, because its cutting form and taste resemble geometry.

Geometry is similar to a fruitcake, because it has addition, subtraction, area calculating, division, angles, length measures ....

Geometry is like a puff cake, because it has a shape similar to puff cake and an enjoyable taste.

Geometry as an indicator of intelligence and mind

7 Participants (4.92%) were found to produce metaphors described as geometry as an indicator of intelligence and mind.

Table 3: Category 3: Geometry as an indicator of mind and intelligence

Metaphor name	Students identified as gifted f	Students identified as non- gifted f	Total f
Mind fuel*	1	-	1
Jigsaw puzzle*	1	1	2
Mind game*	1	-	1
A wise closet*	1	-	1
Compasses*	1	-	1
Computer	-	1	1
	5	2	7

6 different metaphors in which geometry is described as a mind and intelligence indicator were identified. In this category, it is noteworthy that students identified as gifted produced more metaphors. When analyzing metaphors, some emphases have been seen such as; geometry enhances intelligence or only smart ones can solve it. For example;

Geometry is like a mind fuel; because cars run with fuel, and minds run with mathematics.

Geometry is similar to a puzzle; because it is completed with the pieces.

Geometry is like a compass*; because it is a confusing mess which requires a lot of intelligence.

Geometry is like a wise closet*; because as soon as we open it, we can see a lot of good information in.

Infinite Geometry

26 Participants (18.3%) were found to produce metaphors Geometry regarded as infinite. 22 different metaphors which described geometry as infinite were determined. In this category, it is noteworthy that students identified as gifted produced more metaphors. When the metaphors are analyzed, it can be seen some emphases that make highlights on geometry's being infinite and its repeatable changes. For example;

Geometry is similar to a bird*, because when you don't care about it, it flies into the sky forever.

Table 4. Category 4: Infinite geometry

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Bird*	1	-	1
Tape*	1	-	1
Train	-	1	1
Mechanical pencil*	1	-	1
Flying bird*	1	-	1
Chain	-	1	1
Outer space*	1	-	1
Space*	1	-	1
Tunnel	-	1	1
Arrow	-	1	1
Tyre	-	1	1
Universe*	2	-	2
Everything*	1	-	1
Thread*	1	-	1
Chamelon	-	1	1
Fountain*	1	-	1
Dream*	1	-	1
Mirror*	2	-	2
A steady figure*	1	-	1
An endless rope*	1	-	1
Clutch pencil*	1	-	1
Water*	3	-	3
	20	6	26

Geometry is like a flying bird*, because bird flies to the freedom, so geometry leads to the freedom.

Geometry is similar to the universe*, because we always encounter with it and enter to its world.

Geometry is like a clutch pencil, because even though its nib (subject) finishes, we can continue as inserting a new nib (starting new subjects).

Geometry is similar to a fountain*, because new things constantly run and never stop.

Geometry is similar to the water*, because we can transform it to everything.

Geometry is similar to a mirror*, because we look at on it, we can see ourselves and our lives.

Geometry as an inextricable element

18 Participants (12.67%) were found to produce metaphors which qualify geometry as an inextricable element. 15 different metaphors which considered geometry as an inextricable element were identified. The most frequent metaphor was determined to be "brain". In this category, students identified as gifted and non-gifted seemed to produce the metaphors with almost the same number. When the metaphors are analyzed, it is demonstrated that some students perceive geometr as being unpredictable and confusing. For example;

Geometry is like roses and thorns*, because it is difficult to understand and is beautiful.

Geometry is like a puzzle*, because it means to spend a life in vain.

Geometry is like a brain*, because it is very complicated.

Table 5: Category 5: Geometry as an inextricable element

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Adventurous road*	1	-	1
Cave	-	1	1
Shadow	-	1	1
Puzzle *	1	-	1
Knot	-	1	1
Maze	-	1	1
Maze*	1	-	1
Hourglass*	1	-	1
Nail polish	-	1	1
Brain*	2	-	2
Ivy	-	1	1
Problem	1	1	2
Question*	1	1	2
People*	1	-	1
Rose and its thorn*	1	-	1
	10	8	18

Geometry is similar to an adventurous road, because you do not know its end, but you still go.

Geometry is like a maze*, because there is always a way out.

Geometry is similar to a maze, because it is very complicated and you get lost, you try all the ways to get out and you get tired, then you make operation errors and you cannot go out.

Geometry as an Indispensable Element

32 Participants (22.53%) were found to produce metaphors regarded geometry as an indispensable element. 21 different metaphors that described geometry as an indispensable element were defined. The most frequent metaphor was determined to be "life". In this category, students identified as gifted and non-gifted identified produced the metaphors with almost the same number. When the metaphors were analyzed, they demonstrated that geometry was perceived as a constant in life. For example;

Geometry is like your best friend*, because it is the only thing you can hug when you are left alone.

Geometry is like a home*, because we're always in it.

Geometry is similar to to the world, because we use it everywhere, for example; in grocery, in greengrocer...

Geometry is similar to the cake ingredients, because if there is a missing ingredient, the cake will not be good. So, in order to learn math, we need to learn geometry, otherwise we cannot acquire a profession.

Geometry is like a building, because there are layers and a base.

Geometry is similar to the life, because everything is real.

Geometry is similar to a body, because every formula completes each other.

Table 6: Category 6: Geometry as an indispensable element

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Gravity	1	-	1
Food	1	2	3
Brick	-	1	1
Indestructible home	-	1	1
Alphabet	-	1	1
Script*	1	-	1
Road	-	1	1
Home*	1	-	1
Best friend*	1	-	1
Adana kebab*	1	-	1
Life organ*	1	-	1
Life 2	2	2	4
World	2	1	3
Weather	-	1	1
Body	2	1	3
Planet	-	1	1
Sun*	1	-	1
Object	-	1	1
Building*	3	-	3
A piece	-	1	1
Cake ingredients	-	1	1
	17	15	32

Geometry as a Guide

10 Participants (7.04%) were shown to produce metaphors describing geometry as a guide

Table 7: Category 7: Geometry as a guide

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Map	1	1	2
Ruler	-	1	1
Lesson	-	1	1
Domino man	-	1	1
Book	2	1	3
Microscope*	1	-	1
Supermarket	-	1	1
	4	6	10

7 different metaphors which considered geometry as a guide were identified. The most frequent metaphor was determined to be "book". In this category, students identified as gifted and non-gifted produced the metaphors with almost the same number. When the metaphors were analyzed, it demonstrated that geometry is perceived as being a guide and it is full of clues. For example;

Geometry is like a book *, because there is always a clue in its questions.

Geometry is like a domino man*, because there are always some operations that lead to each other. If there is a domino man missing, domino can ruin and the geometry question cannot be solved.

Geometry is like a microscope*, because it requires a millimetric setting.

Geometry is smilar to a ruler, because it always provides for you to draw a straight line.

Geometry as a Popular Element

5 Participants (3.28%) have been shown to metaphors describing geometry to be a popular element.

Table 8: Category 8: Geometry as a popular element

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Plant*	1	-	1
Environment	-	1	1
Flower*	1	-	1
Nature	-	1	1
Love*	1	-	1
	3	2	5

5 different metaphors which considered geometry as a popular element were identified. In this category, students identified as gifted and non-gifted produced the metaphors with almost the same number. When the metaphors are analyzed, it is seen that some emphasis on geometry' having a loved side. For example;

Geometry is similar to a plant*, because if you know how to grow it, it can grow very well and you can do anything.

Geometry is similar to the nature, because it consists of straight lines as in the shapes found in nature.

Geometry is similar to the environment, because there are shapes and geometric objects everywhere and it is very beautiful.

Geometry is like a song, because a good song takes you to the beautiful worlds.

Geometry is like a tree*, because its all branches are different.

Geometry as an Operation and Shape

Table 9: Category 9: Geometry as an operation and shape

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Model	-	1	1
Four operations*	1	-	1
Number	1	2	3
Operation 3	-	3	3
Shapes*	1	6	7
Operation box	-	1	1
Apple counting*	1	-	1
Pen	-	1	1
	4	14	18

18 Participants(12.67%) were found to produce metaphors describing geometry as an operation and shape. 8 different metaphors which considered geometry as an operation and shape were identified. The most frequent metaphor was determined to be "shapes". In this category, students identified as non-gifted seemed

to have produced more metaphors. When the metaphors are analyzed, it is seen that some emphasis on geometry's being a shape, an operation and a calculation. For example;

Geometry is similar to the shapes, because its topics and courses are related to the shapes.

Geometry is similar to the numbers, because there are always numbers in operations and calculations.

Geometry is similar to the numbers *, because we use the numbers in geometry.

Geometry is an operation, because we always do the operations with it.

Other

The metaphors produced by 6 Participants (4.22%) have not been placed in any category headings. These metaphors can be seen in Table 10.

Tablo 10: Category 10: Other

Metaphor name	Students identified as gifted f	Students identified as non-gifted f	Total f
Eraser	-	2	2
Money in the penny	1	-	1
Dice	1	-	1
Animal	-	1	1
Bucket	1	-	1
Truck	-	1	1
Strand	-	1	1
	3	5	6

In the "other" category, 6 different metaphors have been shown to have produced. When the metaphors were analyzed, it was determined that participants produced metaphors which emphasized on different aspects of geometry. For example;

Geometry is like an eraser, because it is continuously lost.

Geometry is like a bucket, because it is empty.

Geometry is like the money in the pennybank, because you do not know where to spend.

Findings and comments about the research problem that is :"Do the metaphors developed by the secondary school students regarding the concept of geometry differ from each other according to students' being identified as gifted or not?" can be analyzed in Table 11.

Tablo11. Distrubitions of metaphors produced by students according to the identified as gifted and non-gifted

Conceptual category	Students identified as gifted	Students identified as non-gifted	Total f
Fun side of geometry	Metaphor:4	Metaphor:7	18
Geometry as a dessert	Metaphor:2	Metaphor:6	9
Geometry as an indicator of	Metaphor:5	Metaphor:2	7
Geometry as infinite	Metaphor:16	Metaphor:6	26
Geometry as an inextricable	Metaphor:9	Metaphor:8	18
Geometry as an	Metaphor:12	Metaphor:13	32
Geometry as a guide	Metaphor: 3	Metaphor:6	10
Conceptual category	Students identified as gifted	Students identified as non-gifted	Total f
Geometry as a popular	Metaphor: 3	Metaphor: 2	5
Geometry as an operation	Metaphor:4	Metaphor:6	18
Other	Metaphor: 3	Metaphor: 4	8

X2=15.01; sd=8.88; p=, 000

Even very large differences can not be seen in the metaphors produced by two groups, it is noteworthy that the students identified as gifted produced more metaphors in the categories of "infinite geometry" (76.8%)

and “geometry as an indicator of mind and intelligence” (71.4%). The students identified as non-gifted were found to have produced more metaphors in the categories of “geometry as an operation and a shape” (87,8%), and “geometry as a dessert “ 77.77%). There was no significant difference for statistically between gifted and non-gifted students.

Dıscussıon, Conclusion And Recommendations

This study was designed in order to reveal the geometry concepts of the secondary school students who were identified as gifted and non-gifted with the help of metaphors, to collect these metaphors under certain conceptual categories and to determine the differences between the studied groups of students. The findings have been drawn attention to a few important points.

To be able to describe the concept of geometry as a whole, it has been demonstrated that numerous metaphors are needed. In this study, students were found to produce 142 different valid metaphors on the concept of geometry. In this context, it suggests that the geometry concepts cannot possibly be explained by a single metaphor. Katranci, Apak and Akdag (2011) obtained similar results in their study. In a study conducted by prospective teachers who were studying in Primary School Mathematics teaching, it has been revealed that 70 different metaphors were produced related to the concept of math teacher. In Cerit’s study (2008), it was seen that only one metaphor was not preferred for the concept of teacher. In other metaphor cases, a similar situation is observed related to the different concepts or facts. The following researchers conducted metaphor studies on the following concepts: Liston and Zeichner (1991), Andrews and Hatch (2000); Stigler and Hiebert (1999), Guerrero and Villamil (2002) and Saban, Kocbeker and Saban (2006) on "teacher"; Aydin and Wrestler (2010) on "teacher" and "student" ; Cerit (2008) and Saban (2009) on "students"; Saban (2008) on "information"; Aydogdu (2008) on "school"; Aydin (2010) and Ozturk (2007) on "geography"; Afacan (2011) on "science" and "science teacher"; Bahadir and Ozdemir (2012) on “mathematics"; Noyes (2006) on "math teacher"; and Dos (2010) on"inspector". Producing of numerous metaphors is consistent with the findings. In these studies, the number of metaphors have been seen to have been produced about relevant concepts. This study, in this context, has shown parallelism with the other aforementioned studies.

In this particular study, when the metaphors produced by secondary school students about the concept of geometry are analyzed, the most preferred metaphors are seen as games (f = 9) and shapes (f = 7). Demanded characteristics of the most preferred metaphors are analyzed from their sources to their topics, students are seen to have a positive attitude about the concept of geometry. Metaphors can be used a powerful research tool in understanding, revealing and expressing the perception of students regarding the geometrical concepts. Considering the negative expressions revealed through metaphors, math teachers can help students to develop positive attitudes. Additionally, in parallel with our findings that the students who were identified as gifted have been seen to be more successful to produce metaphors than the ones who were identified as non-gifted, the other studies (Mertol, Dogdu, Yilar, 2013; Kunt, Kartop 2013) which were done about the gifted children’s producing metaphors also showed similarity with the findings that the gifted students could produce a variety of metaphors and didn’t seem to produce invalid metaphors or blank answers.

The most common situation for the invalid metaphors was the case in which students who were identified as non-gifted left the papers blank because they did not know how to answer or used the same sentences which the teacher gave as an example. These findings suggest that students struggle with making comments related to a topic and assigning meanings to their feelings. These students need further guidance in order to be able to express themselves. There was no much categorical difference between the groups of surveyed students, but students who were identified as gifted have been seen to produce more consistent and effective metaphors than their peers who were identified as non-gifted. This case and their positive situation on perceiving geometry suggest that they have a higher self-esteem and have self-expression skills.

The metaphors produced by the students identified as gifted and non-gifted have demonstrate that students mainly identify geometry as an infinite and an indispensable element and that they believe that geometry can reflect various aspects of life with its natural qualities. This contributes to the importance of geometry as a necessary course.

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