Gifted students’ metaphor images about mathematics

Elif Esra ARIKAN* and Hasan UNAL
Yildiz Technical University, Istanbul, Turkey.

Received 15 February, 2015; Accepted 24 March, 2015

The aim of this study is to investigate the metaphors images of gifted students about mathematics. The sample of the study consists of 82 gifted students, which are 2, 3, 4, 5, 6, 7 graders, from Istanbul. Data were collected by asking students to complete the sentence: “Mathematics is as ..., because...”. In the study content analysis was used. The metaphors which were generated by students were categorized in terms of perceptions of mathematics. Metaphors were classified by three categories as content of mathematics, function of mathematics and exhibit attitude to mathematics. Chi-square test was used for examining relationship between two qualitative variables which are grades and metaphors. One of the findings is that gifted students generated metaphors according to their attitudes to mathematics.

Key words: Metaphor, mathematics, gifted students.

INTRODUCTION

Research on metaphors, dating back to the work of Aristo (B.C. 386-322), treats the usage of language and eloquence. Lakoff and Johnson (1980) mention that our mentality is formed with metaphors (Otyzbayeva, 2006). Metaphors are used as a pedagogical tool, an assessment tool, a mental tool in education (Saban, 2006). Metaphor makes it easy to conceptualize and helps to configure knowledge. Most research studies in mathematics education on the use of metaphor have presented that metaphor highlights the importance of education. Metaphors produce a conceptual relationship between a source domain and a target domain because of linking different senses. Though conceptual metaphor is related to person building it, teachers use metaphor to help students’ understanding (Lakoff and Nunez, 1997). Therefore, while talking about abstract concepts, the usage of metaphors provides coherence of meaning.

Metaphors are experiences that are acquired from our daily lives and they are conceptual. Metaphors are indispensable in the comprehension process of abstract notions. Because of conceptuality, metaphors are shaped according to different cultures (Lakoff and Johnson, 2005).

According to Lakoff and Johnson (1980) in addition to providing new understandings, metaphors which are defined simply as ‘understanding something from another perspective’ create our thoughts and actions at the same time. For MacCormak (1990) ‘the basis of a metaphor is to refer to the concepts that we know and recognize for explaining something unknown and it is the extraordinary sequence of the things which are familiar and which are not familiar to us.’ According to Cerit (2008) people use metaphors when they know little or do not know much about the concept and terminology about the case that they want to explain. For instance, someone who says ‘Turkish is like a mother’s milk’ while defining our mother

*Corresponding author. E-mail: arikanee@gmail.com.

Authors agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License.
tongue which is one of the basic components of our life, explains it by emphasizing the mother’s milk which is more familiar to him/her and which has a basic and vital function like the mother tongue itself. That is to say, explains the meaning of this basic component by moving from mother’s milk metaphor. According to the researchers who moved from the Lakoff and Johnson’s definitions about metaphor concept, metaphors have a shaping effect on our thinking styles, languages and science and also on the way for expressing ourselves in our daily lives (Morgan, 1998). In this regard, metaphor has been used in many studies in recent years. The purpose of these studies which were carried out in this method is to try to present the perception style of different concepts by people through metaphors.

People perceive and understand their environment; as a matter of fact if we discuss it from a wider perspective, the world, in many different dimensions from each other. The answers of the questions such as where to live, where to shop and where to visit base on our perceptions about the places such as beautiful or ugly, good or bad, safe or dangerous. The environmental issues are important factors on the emphasis given for the environmental education and the determination of the perceptions about environmental issues has a discrete importance as it will reveal the attitudes of individuals about the problem. Because, it will be wrong to claim that there is a single solution and a single method for the solution of the problems about the environment as in all fields. Thus, the previous studies state that environmental education is an effective as it is expected and should be freed memorization. In the process of understanding the perceptions of individuals, effective results can be obtained by looking at their metaphoric intellectual worlds.

Because, the metaphors are cognitive concepts which enable people to be able to discuss any subject from different perspectives in order to be able to express their thoughts about it. With the evaluation of these concepts, it is provided to understand subject which is discussed from different perspectives and to shape it according to reality (Morgan, 1998; Berci, 2007).

60 teachers participated who teach vocational and technical courses perceived themselves as a zookeeper, a maestro, a judge and puppeteer (Ben et al., 2003). While the teachers of students with low performance defined themselves as zookeeper, the teachers of students with high performance defined themselves as a maestro. They also stated that metaphors are important perception tools in education and it is possible to reveal underlying beliefs and assumptions about teachers’ roles in the classroom, students and education through metaphors.

The features of a metaphor can be classified as Tompkins and Lawley (2000): for a concept;

(i) defining a concept with a different one

(ii) describing through the analogical feature of a different concept,

(iii) seeing in different dimensions and with a different form.

Metaphors can be living and nonliving things, abstract and concrete and also they can be positive and negative. Metaphors which can be used as a tool for collecting information and interrogation at the same time enable one to understand subjects which were not understood sufficiently. Besides, they play an important role in presenting the problems overtly and providing abstracts for the thoughts.

Uğar et al. (2010) asked from primary school students to illustrate the mathematics and the mathematician of their dreams. In addition to that it was aimed to collect students’ thoughts about mathematics and mathematician concepts through written documents. When pictures and writings were analyzed, it was determined that students perceived mathematics as a ball of numbers and mathematicians as unsocial and introvert persons. Öflaz (2011) searched the perceptions of primary school students regarding mathematics teacher concept. It was determined as a result of the study that students wanted a mathematics teacher who is caring, affectionate, merciful, easy to communicate with and non-judgmental when they ask him/her questions. Guler et al. (2012) analyzed the metaphoric perceptions of secondary school prospective mathematics teachers about ‘mathematics’ concept. 5 categories appeared in the study. These categories are; the necessity, advisor, infinity, perspective and the life itself. Yılmaz et al. (2013) asked prospective teachers to create metaphors about ‘teacher’ concept. The categories obtained as a result of the analysis are as in the following; formatting teacher, advisor teacher, source of information teacher, non-status teacher, flexible teacher, role-model teacher, teacher carrying out a sacred work. Ada (2013) analyzed the perceptions of 6th, 7th and 8th grade students about ‘mathematics’ and ‘mathematics teacher’ concepts with the help of metaphors in his published master’s thesis. According to data which were analyzed with content analysis, students generally interpreted mathematics concepts as a difficult and boring lesson. In addition to this; it was also described as enjoyable, comprehensive and requiring intelligence. It was asserted as ‘a smart person’ for the ‘mathematics teacher’ by the majority of the sample. According to chi-square test carried out in the study, it was determined that as the grade levels of the students and their parents’ educational levels increased, the student displayed negative attitudes towards ‘mathematics teacher’ and ‘mathematics’ concepts. Güner (2013) asked the opinions of classroom, social sciences and primary school mathematics prospective teachers about ‘mathematics’ concept. Whereas the idea of ‘mathematics makes their life complicated’ became prominent among social sciences
prospective teachers, classroom prospective teachers generally emphasized the idea that ‘mathematics is an amusing engagement’. Primary school prospective mathematics teachers mostly stated the idea that ‘mathematics is simply the life itself’.

Picker and Berry (2000) asked to draw their mathematics teacher from the seventh and eighth graders at five different elementary schools in five different countries. When analyzed the metaphorical, students had drawn threatening, violence, despot and rigorous people figure.

Inbar (1996), in this study, 409 primary students and 254 educators participated who offered metaphors for the concept of student, teacher and school principal. When students were perceived as a vegetation by many of the educators, educators were perceived as a super lock by many of the students. The concept of school principal was perceived as an author by students and educators. The concept of school was perceived as a framed the world by many of the students and educators.

Researchers proposed to investigate the dynamic process of teaching and learning of graph fiction in high school in Spain (Frant et al., 2005). Researchers looked for answers to the following questions: what kind of metaphors was used for explaining the graphic representation of functions by teacher, did teacher realize metaphors which uses, what effect of metaphors which teacher uses was on his/her students, what was the role played by metaphors in the negotiation of the meaning.

The importance and purpose of the study

At the beginning of the study, we assumed that gifted students generate metaphors about mathematics related to its function in real life. It was examined whether categories of generated metaphors vary according to class level which means primary (2,3,4) and secondary (5,6,7).

METHOD

The research method of this study was case study. Case study is one of the methods of qualitative research. The sample consisted of 82 gifted students who were at 2, 3, 4, 5, 6 and 7 graders from private primary school in Istanbul. The participants were requested to complete semi-structured sentence: “Mathematics is as..., because...”.

Data collection

Content analysis technique was used on collected data.

Data analysis

Data were analyzed both qualitatively and quantitatively. First of all, three phases were implemented. Generated metaphors by gifted students were a) coded as concept (sea, water, fish, game and etc.), b) classified according to topic, source and connection of topic and source, c) examined in terms of common characteristic independently of researchers. Afterwards, researchers compared their lists of metaphoric images. Researchers found the least common denominator.

Chi square test was only used when all expected values in nxn tables have to be above 5. For this reason, we implemented Chi square test for determining the link between gender and metaphorical categories and also school levels and metaphorical categories.

Participants

Gifted students

According to Ministry of Education Science and Art Centre (SACs) Directive’s j clause of 4th article of the definitions section, gifted students are defined as in the following; j) Gifted Child/Student: The child/students who are specified by the experts that they display higher performances than their peers in intelligent, creativity, art, leadership capacity or special academic areas (BILSEM Instructions, 2007). The Wisc-r test score of all the gifted students who participated in this thesis study was determined as 135 ZB or over. The class was opened for gifted students without classifying their talents regarding on which field they are more talented by predicting the contribution of environmental factors (selection of school and class etc.) to their academic achievements. This case is included in literature as ‘full special classes. It helps to create a full-time homogenous group (Sak, 2012). ‘Full special classes’ environmental factor is seen as important for gifted students to get academic achievements (Rogers, 2002). A gifted individual displays abnormal performances in one or more areas and succeeds in developing creative and innovative ideas (Budak, 2008). A gifted individual grows up earlier than his/her peers and maintains his/her development in a larger period than normal. For example, a gifted individual maintains his/her development till older ages than the development age of a non-gifted individual (Winner, 1996). It is stated in literature that gifted students understand the concepts quickly, think flexible, open to discoveries, analyze the details and have high ethical senses (Reynolds and Birch, 1988). Jost emphasizes that gifted children have higher potentials than their peers but it is not always possible to convert this potential into performance automatically (Jost, 2006).

Furthermore, gifted students were coded according to school level. Primary school students were coded as P1, P2,..., P46 and secondary school students were coded as S1, S2,..., S36.

FINDINGS

According to the results of the study, generated metaphors by gifted students were identified in 3 categories. The participants generated metaphors related to their approach to mathematics.

56% of the participants were from primary school level and the rest of the participants were secondary school level. Demographic information of the participants is placed in Table 1.

Gifted students of Secondary school generated 26 metaphors which are respectively; water (4), life(4), blood (3), game (3), logic, flower, lamp, history, tree, sea, clue, key, secret, fish, sun, star, space, lastic, cafein, mind, maze, atom, potato sack, blind-alley, loop and seed (Table 2).
Gifted students of primary school generated 32 metaphors which are respectively; life (4), shine (4), teacher (3), puzzle (3), water (2), heart (2), tree (2), flower (2), house, knowledge, gifted knowledge, calculator, way, game, star, ice-cream, computer, world, mind, brain, fire, smart board, compass, strand, time streaming, mint, planet, a brain box, cave, profession, matter, building.

Chi square test is calculated in Table 3. Hypotheses are as follows:

\[ H_0 = \text{Gender and metaphors are independent qualitative variables} \]
\[ H_1 = \text{Gender and metaphors are dependent qualitative variables} \]

According to result, degree of freedom is 2 (for categories and gender) and \( \chi^2_{0.01;2}=9.21034 > \chi^2_{0.01;2} \), then qualitative variables which are gender and metaphoric images are independent.

Moreover, degree of freedom is 2 (for categories and school levels); hypotheses of chi square test are as follows:

\[ H_0 = \text{School levels and metaphors are independent qualitative variables} \]
\[ H_1 = \text{School levels and metaphors are dependent qualitative variables} \]

\( \chi^2_{0.01;2}=9.21034 > \chi^2_{0.01;2} \text{Yates} = 1.4 \).

Hence, these two qualitative variables which are metaphoric images and school degree (primary and secondary level) are independent variables.

**Examples of generated metaphors**

**Category 1**

Mathematics is as compass. Because both of them guide to us (P11)
Mathematics is as water. Because we cannot live without water (S24)

**Category 2**

Mathematics is as trees. Because trees have boughs (P36)
Mathematics is as a clue. Because it helps us to make out (S20)

**Category 3**

Mathematics is as a fish. If you go straight, you can pick the bones of fish, and eat (P28)
Mathematics is as a lastic, because lastic gets longer as long as you pull (S7)

**DISCUSSION**

Respectively, metaphoric categories-gender and metaphoric categories-school level were identified as independent qualitative variables. Generated metaphors by gifted students were predominantly in category 1. Actually, it was surprise for us. Because, we expected that gifted students generate metaphors about using of mathematics in real life. Probably, this is due to students' perception of mathematics as a lesson only and not linking mathematics and real life.

Students perceive mathematics as a difficult lesson in the study carried out by Oflaz (2011) and the number of students who accepted mathematics as necessary was less. However, in this study, gifted students whether they like mathematics or not accepted the necessity of mathematics. In Sterenberg (2008)'s study primary school students perceived mathematics as a struggle in a similar way to this study. In Wood (2008)'s study which was carried out with 1200 university students, many students see mathematics as a tool for their future professional lives. Similarly, 20 % of the students in this study considered mathematics as a tool while producing metaphors.

In Şahin (2013)'s study the metaphors about mathematics and mathematics teachers were asked to prospective teachers from various departments of the university and while prospective teachers who frequently use mathematics and have successful results perceived mathematics as enjoyable, prospective teachers on the opposite case generally used negative metaphors. This result overlapped with the studies of Güler et al., (2012) in which prospective mathematics teachers produced metaphors such as guiding, eternity, necessity and indispensable part of life regarding the mathematics concept that they have.

In Kılç (2011)'s study which was carried out comparatively, the result which mostly occurred commonly in metaphors of mathematics teachers in Belgium and Turkey about mathematics was puzzle. Cultural, regional, national and international factors were stated as for the reason of the other different metaphors. The effect of teachers is major on establishing positive attitudes towards mathematics among students. According to Megay-Nespoli (2001) when teachers create a positive classroom atmosphere, the motivations and cognitive developments of students are positively affected and in accordance with this their academic achievement increases. Besides, according to Bloom (2012) affective...
Table 2. Distribution of metaphors according to categories.

| Categories of metaphors       | Primary School Students | Secondary School Students |
|------------------------------|-------------------------|---------------------------|
| Function of Mathematics      | Life (4), teacher(3), water(2), heart(2), computer, mind, brain, smart board, compass, mint | Water (4), blood(3), logic, clue, key, secret, mind |
| Content of Mathematics       | Tree(2), flower(2), house, world, building | Flower, history, tree, sea, space, atom, potato sack, blind alley, loop and seed |
| Attitude to Mathematics      | Shine(4), puzzle(3), knowledge gifted knowledge, calculator, way, game, star, ice-cream, fire, strand, time streaming, planet, brain box, cave, profession, matter | Life(4), game(3), lamp(2), fish, sun, star, lastic, cafein, maze |

Table 3. Metaphoric images distribution according to gender.

| Categories of metaphors | Gender |
|-------------------------|--------|
|                         | 2-3-4  | 5-6-7  |
| Function of Mathematics | Female | Male   |
| Content of Mathematics  | 17     | 12     |
|                         | 9      | 20     |
| Attitude to Mathematics | 7      | 9      |
|                         | 10     | 6      |
|                         | 22     | 15     |
|                         | 13     | 24     |

features are one of the reasons of individual differences while learning and the effect of this on the variety among others while learning is one fourth. Teachers should be in a supportive manner against their students by considering all of them.

Conclusion

Metaphor refers to a clue related with one's idea about a concept (Levine, 2005). For this reason, we explored gifted students' metaphoric images link with mathematics concept. 2,3,4 graders of primary school and 5,6,7 graders of secondary school gifted students joined this study. According to findings, three categories came out in the result of classification. It was found that metaphor categories depend on neither gender nor school level.

Assessment of the metaphors in terms of the gender

It has been detected that the male students have been much more related with the functionality of mathematics and they have produced much more metaphors concerning the usage of it in the daily life than the female students. However, both female and male students have mostly preferred to produce metaphors concerning the attitudes against the mathematics itself.

Assessment of the metaphors in terms of the level of the school

There has been a situation which is very similar to the one of the results obtained from the sexuality aspect. That is, the both students who have been coming from the two school levels have mostly produced metaphors concerning the attitudes against the mathematics itself. Another significant point recognized during the increase in the school level is that there has been a decrease in the quantity of producing metaphor concerning the functionality of the mathematics while there has been an increase in the quantity of producing metaphor concerning the content of the mathematics. This case reveals the question whether the creativity of the students has been decreased during the progress in the level of their schools or they think the school mathematics far from the daily life. The required updated works have to be carried out related with this situation.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES

Ada S (2013). Öğrencilerin Matematik Dersine Ve Matematik Öğretmenine Yönelik Algılarının Metaforlar Yardımcısı Belirtenleri. Yüksek Lisans Tezi, Eğitim Bilimleri Enstitüsü, Gazi Üniversitesi, Ankara.
Ben-Peretz M, Mendelson N, Kron FW (2003), “How Teachers In Different Educational Context View Their Roles”, Teaching Teacher Educ. 19:277-290.
Berci ME (2007). The autobiographical metaphor: An invaluable approach to teacher development. J. Educ. Thought, 41(1):63-89.
Budak G (2008). Yetkinliğe Dayalı İnsan Kaynakları Yönetimi. İzmir: Barış Yayınları.
Cerit Y (2008). “Öğretmen Kavramı İle İlişkili Metaforlara İlişkin Öğrenci, Öğretmen ve Müdürülerin Görüşleri”. Ankara: Türk Eğitim Bilimleri Dergisi, 4(6):693-712.
Frant AF (2005), Cognição corporificada e linguagem na sala de aula de matemática: analisando metaforas na dinamica do processo de ensino de graficos de funções. BOLETIM GEPEMON, 46:41-54.
Güler G, Akgün L, Ocak MF, Doruk M (2012). “Matematik Öğretmeni Adaylarının Matematik Kavramına İlişkin Sahip Oldukları Metaforlar”, Eğitim ve Öğretim Araştırmaları Dergisi, 1(2).
Güner N (2013). “Öğretmen Adaylarının Matematik Hakkında Oluşturdukları Metaforlar”, E-Journal of New World Sci. Acad. 8(4):428-440.
Inbar D (1996). The free educational prison: Metaphors and images. Educ. Res. Rev. 38(1):77-92.
Jost M (2006). İleri Zekâlı Çocuklar Tespit Etmek ve Desteklemek (Çev. A. Kanat) İzmir: İlya İzmir Yayını.
Kliç Č (2011), Belgian and Turkish Pre-Service Primary School Mathematics Teachers’ Metaphorical Thinking About Mathematics. CERME 7 (Committee at the Seventh European Conference on Research in Mathematics Education), Rzeszow, Poland.
Lakoff G, Johnson M (1980). Metaphors We Live By. Chicago: Chicago University Press.
Lakoff G, Núñez R (1997). The metaphorical structure of mathematics: Sketching out a cognitive foundation for a mind-based mathematics. In: L. English (Hrsg.), Mathematical reasoning: Analogies, metaphors, and images (S. 21–89), Mahwah, NJ: L. Erlbaum Associates.
Lakoff G, Johnson M (2005), Metaforlar, Hayat Anlam ve Dil (Metaphors We Lived By), Çeviren: Gökhan Yavuz Demir, IL: The University Of Chicago Press, Chicago.
Levine PM (2005). Metaphors and Images of Classrooms, Kappa delta Pi Record. 41(4):172-175.
Tompkins P., Lawley J (2000). Metaphors in mind. Transformation through symbolic. Published by The Developing Company Press.
Megay-Nespol K (2001). “Beliefs and Attitudes of Novice Teachers Regarding Instruction of Academically Talented Learners”, Roever Review, 23, s. 178-182.
Morgan G (1998). Yönetim ve Örgüt Teorilerinde Metafor. (Çev. G. Bulut), İstanbul: Türkiye Metal Sanayicileri Sendikası.
Oflaz G (2011), “İlköğretim Öğrencilerinin “Matematik” ve “Matematik Öğretmeni” Kavramlarına İlişkin Metaforik Algıları”, 2nd International Conference on New Trends in Education and Their Implications, 27-29 April, Antalya-Turkey.
Otyzbayeva Z (2006). Kazak Yazar Dükenbay Dosjanov’un İpek Yolu Romanında Metaforlar, Yüksek Lisans Tezi, Ankara Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara.
Picker SH, Berry JS (2000). “Investigating pupils’ images of mathematicians”, Educational Studies in Mathematics, 43(1):65–94.
Reynolds MC, Birch JW (1988). Adaptive Mainstreaming (A Primer for Teachers and Principals). London: Longman Inc.[40] Wink, J (1997), Critical pedagogy; Notes from the real world. New York: Longman.
Rogers KB (2002). Re-forming gifted education: Matching the program to the child. Scottsdale, AZ: Great Potential Press.
Saban A (2006). Functions of Metaphor in Teaching and Teacher Education: A review essay. Teach. Educ. 17(4):299-315.
Sak U (2012). Üstün Zekâlalar: Özellikleri, Tanımlanmaları, Eğitimleri. Vize Basın Yayın, 2. Baskı, Ankara.
Sterenberg G (2008). Investigating Teachers’ Images Of Mathematics. J. Math. Teacher Educ. 11:89-105.
Şahin B (2013). “Öğretmen Adaylarının “Matematik Öğretmeni”, “Matematik”, ve “Matematik Dersi Kavramlarına İlişkin Sahip Oldukları Metaforik Algıları, Mersin Üniversitesi Eğitim Fakültesi Dergisi, Cilt 9, Sayı 1, 313-321.
Uçar TZ, Pişkin M, Akbaş NE, Taşçı D (2010). “İlköğretim Öğrencilerinin Matematik, Matematik Öğretmenleri Ve Matematikçiler Hakkındaki İnançları”, Eğitim ve Bilim. 35.
Winner E (1996). Gifted Children.: Myths and Realities. New York: Basic Books.
Wood LN (2008). Engineering mathematics-what do students think? Anziam J. 49:513-525.
Yılmaz F, Göçen S, Yılmaz F (2013). “Öğretmen AdaylarınınÖğretmen Kavramına İlişkin Algıları: Bir Metaforik Çalışma”, MersinÜniversitesi Eğitim Fakültesi Dergisi, 9(1):151-164.