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Searching for the Exit in a Maze? Or Setting Sail for New Horizons? Metaphors by Twelfth Grade Students for Learning Mathematics

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Abstract

This study examines and classifies the metaphors that twelfth grade students formulated to describe the concept of "learning mathematics". The sample of the study consists of 669 twelfth grade students (317 female, 352 male) of two Anatolian and two vocational high schools located in the city center of Denizli. The following questions guided this study: What metaphors do students use to describe the concept of "learning mathematics"? What conceptual categories can be derived from these metaphorical images? How these conceptual categories differ by high school type? How these conceptual categories differ by students' gender? The data were analyzed both qualitatively and quantitatively. According to the results, 76 valid metaphors and eight main conceptual categories were identified. These main conceptual categories are: discovering an unknown, learning a new skill, solving a puzzle, learning the rules and playing a game, using a tool, difficulties of learning mathematics, pleasure of learning mathematics, having a hardship. According to Pearson chi square calculations Anatolian high school students and girls produced more metaphors about enjoying mathematics than vocational high school students and boys. Also, vocational high school students and boys produced more metaphors about difficulties of learning mathematics and having a hardship than Anatolian high school students and girls.

Key Words

Metaphor Analysis, Learning Mathematics, Anatolian High School, Vocational High School.

Today, almost all professions require mathematical thinking to some degree. This necessitates solving problems by means of reasoning rather than operational mathematics skills. Mathematics enables us to solve everyday problems by establishing cause and effect relationships. Today, all countries attach great importance to effective teaching of mathematics. However, Turkish students generally display below-average performance in international exams such as TIMSS (Trends in International Mathematics and Science Study) and PISA (OECD Programme for International Student Assessment) (Eğitimi Araştırma Geliştirme Dairesi Başkanlığı [EARGED], 2008).

In their book Lakoff and Johnson (1980) examined use of metaphors in daily language and in English literature say "Metaphor is principally a way of conceiving of one thing in terms of another, and its primary function is understanding" (Lakoff & Johnson, 1980, p. 36). Metaphor as a concept is regarded as mental instrument that an individual uses to understand and explain a concept or an abstract fact. Metaphor is a shortcut to revealing existent mental schemas. In addition, metaphor sheds light on a certain aspect of any concept when it is verbalized (Saban, Koçbeker, & Saban, 2006). Fleener, Pourdavood and Fry (1995, p. 3) emphasize another aspect of using metaphor as: "The role

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of metaphor for organizing and communicating thoughts about one's personal reality is central to individuals' knowledge and experiences."

Many studies within the literature on education have examined the feelings, thoughts and opinions of participants via analysis of metaphors. Some of these studies are on the feelings and opinions of teachers and pre-service teachers regarding the teaching profession (Ben-Peretz, Mendelson, & Kron, 2003; Cassel & Vincent, 2011; Cerit, 2008; Martinez, Sauleda, & Huber, 2001; Saban, 2004; Saban et al., 2006). The literature also includes studies on perceptions of school among students, parents, teachers and school principals (Balcı, 1999, 2011; Demir, 2007; Inbar, 1996).

Previous metaphor analyses about mathematics, mathematics teacher, teaching and learning mathematics include studies that examined the opinions of primary school, high school and university students, teachers, academicians and adults (Allen & Shiu, 1997; Fleener et al., 1995; Lim, 1999; Noyes, 2006; Reeder, Utley, & Cassel, 2009; Schinck, Neale, Pugalee, & Cifarelli, 2008; Sterenberg, 2008; Wood, 2008). In one study, ninth and tenth grade students were asked to write a metaphor for mathematics. Most of the students emphasized the hardship of learning mathematics, its hierarchical structure and its use as an instrument; they also associated mathematics with embarking on an expedition of discovery (Schinck et al., 2008).

Allen and Shiu (1997) work on university students' and teaching assistants' and Noyes (2006) studied pre-service high school mathematics teachers' metaphors about teaching and learning mathematics. Results of both studies show that participants regarded mathematics as a language, journey to unknown, solving a puzzle, a tool kit and a hierarchical structure (Allen & Shiu, 1997; Noyes, 2006).

In his Ph.D. thesis Lim (1999) worked on metaphorical images of mathematics given by adults. He found three common categories of metaphors about mathematics; as a journey, a skill and as a game or puzzle. Wood's (2008) research on 1200 university students from five countries show that, most students view mathematics as a tool to use in their professional lives.

Similarly, in Turkey, Oflaz (2011) conducted a study on 40 eight grade students' perception about mathematics and mathematics teacher. As a result eight graders' mathematics images collected in six categories (Oflaz, 2011). Güveli and her colleagues worked on 200 pre-service elementary school teachers' metaphorical images on mathematics. Three most used conceptual categories were; "mathematics as an exciting class, a hard and dull class and mathematics being made up of various subjects" (Güveli, İpek, Atasoy, & Güveli, 2011, p. 157).

Research Problems

Turkish students enroll in high schools according to their academic background. Students who are successful in primary education usually enroll to Anatolian high schools. Whereas students who have weaker background generally attended to vocational high schools to learn a profession. The aim of this study is to determine the feelings and thoughts of twelfth grade students of Anatolian and vocational high schools about "learning mathematics" by using metaphor analysis method. The research problems are as follows:

1. Which metaphors do students use to describe learning mathematics?
2. Under which conceptual categories can those metaphors be collected in terms of their common traits?
3. Is there a relationship between conceptual categories and the types of high schools?
4. Is there a relationship between conceptual categories and gender of students?

Method

Participants

The study included 669 twelfth grade students. Of these, 323 were from Anatolian high schools (169 female, 154 male) and 346 were from vocational high schools (148 female, 198 male). Overall, 317 students were female (47.4%) and 352 students were male (52.6%); 48.3% were from Anatolian high schools and 51.7% were from vocational high schools.

Data Collection Tool

The researcher prepared a two-part questionnaire that was used as data collection tool. The first section consisted of questions on the students' schools, classes and genders to determine their demographic characteristics. The second section consisted of an open-ended question to determine the participants' experiences gained during their mathematics education. The open-ended questions aimed to offer

participants the opportunity to freely express their feelings and thoughts (Creswell, 2007).

Data Collection

Data were collected during the fall term of the 2011–2012 academic year. The study was conducted during Turkish literature classes. During data collection, the researcher and high school Turkish literature teachers used previously prepared material to inform participants about the study. Students were given half an hour to answer demographic questions and produce a metaphor to express their feelings and thoughts on learning mathematics.

Data Analysis

Completed questionnaires were read by the researcher prior to classification. During the first reading, 103 questionnaires were excluded from coding. The remaining 669 questionnaires which were answered appropriately were then coded. Information related to the questionnaires where all the demographic questions were answered and a valid metaphor was produced by the student was written in the computer environment for thematic classification and statistical analysis.

Classification of Metaphors and Developing the Themes

The 669 metaphors were re-read and were analyzed via content analysis method. Content analysis is explained as the determination, counting and interpretation of repetitive subject, issue and concepts within the obtained data (Denzin & Lincoln, 1998; Miles & Huberman, 1994; Silverman, 2000). Following examination of all the metaphors, 76 different metaphors were determined. After that, by using predominant characteristics of metaphors researcher and an expert of metaphor analysis named eight major themes for conceptual categories.

Reliability of the Study

The determined 76 metaphors were listed alphabetically and were collected in a file together with examples of metaphors. Then, expert assigned each metaphor into eight conceptual categories. The researcher repeated the same procedure independently of the expert. The reliability of the operation of appointing the metaphors to the conceptual categories was calculated as 92%. The metaphors that were initially allocated to different groups were jointly reviewed by the researcher and the expert, resulting in 96% agreement.

Presentation of the Data

Frequency tables indicating the student gender and types of high schools were drawn for metaphors classified according to the conceptual categories. Example metaphors were given by stating the questionnaire number, gender of the students and the type of high school. In addition, the Pearson chi-square test was used to determine whether the eight conceptual categories differed according to the type of high school and gender of the student.

Results

Metaphors That Students Use to Describe Learning Mathematics

Mostly, students described learning mathematics via metaphors such as solving puzzle (65), playing computer games (50) and discovering/learning the life (47). From the answers that the participant gave, 76 different metaphors were obtained, 15 of which were each used by only one student (8 female and 7 male). In addition, it was observed that six metaphors were used by only female students or only male students. The metaphors that students created were classified under eight categories: (1) discovering an unknown, (2) learning a new skill, (3) solving a puzzle, (4) learning the rules and playing a game, (5) using a tool, (6) difficulties of learning mathematics, (7) pleasure of learning mathematics, (8) having a hardship.

Discovering an Unknown: Under this conceptual category, 111 students used 10 different metaphors. The most commonly used metaphors relate to discovering/learning the life (47), setting out on a journey (21), discovering the world (11) and discovering the space (10).

Learning a New Skill: Among the participants, 88 students used 12 different metaphors that regard mathematics as a skill required to be learned. Of these students, 42 were from Anatolian high school and 46 were from vocational high school. The number of male students (50) was higher than the number of female students (38). The most frequently used metaphors included learning to speak (19), learning swimming (17), learning to drive a car (15), learning a new language (12) and learning to ride a bike (12). Such metaphors as a bird's learning to fly, learning to skate and learning paragliding were each used by one student.

Solving a Puzzle: In this section, 123 students described learning mathematics as solving a puzzle and created eight different metaphors in total. Metaphors such as playing memory and strategy games, and decoding were each used by only male students. The most of the 8 different metaphors within this conceptual category were: solving a puzzle (65) and playing memory games (25).

Learning the Rules and Playing a Game: In this section, 121 students associated mathematics to a game and learning mathematics to learning the rules and playing a game. The most commonly used metaphors under this category were: playing computer games (50), playing game (21) and playing games with numbers (21).

Using a Tool: Under this category, 28 students stated that they regarded mathematics as a tool, and likened learning mathematics to using a tool. These students created seven different metaphors. The most common metaphor (use by 12 students) was about a required tool for the university entrance exam. In addition, of 6 metaphors used in this section, using highway, being vaccinated and taking medication were each used by only one student.

Difficulties of Learning Mathematics: Within this category, 88 students created 16 different metaphors for the difficulties of learning mathematics. Most of these metaphors were created by students who studied at vocational high schools. The most commonly used metaphors were: looking for the exit in a maze (12), being unable to swim (11), a tough race (11) and climbing a mountain (10). Metaphors such as working at a building construction site, walking on thin ice, learning Chinese, and looking for water in a desert were used only by female students.

Pleasure of Learning Mathematics: The students who thought that learning mathematics was enjoyable were mostly female and from Anatolian high schools. The two most commonly used metaphors were: listening to music (12) and reading a gripping novel (11). Metaphors such as watching TV series, putting a make-up, watching films and drinking Turkish coffee were used only by female students.

Having a Hardship: Students created six different metaphors under this category. The most commonly used metaphors were torture (23) and suffering pain (12). The metaphor of passing through a horror tunnel at an amusement park was used by a female student and the metaphor of biting tree branches was used by a male student.

The chi-square test was used to determine whether the eight conceptual categories identified within the study differed according to the type of high school and students' gender. A significant difference (x^2 = 32,314,p = 0,000) was found between the categories and types of high schools. These differences are in favor of students who study at Anatolian high schools for the categories of discovering an unknown and enjoying learning mathematics. Students at vocational high schools created more metaphors for the difficulties of learning mathematics and having hardship.

The chi-square test also showed a significant difference (x^2= 17,531, p = 0,014) between the gender of the students and the conceptual categories. Female students used more metaphors of learning the rules and playing a game and pleasure of learning mathematics. In addition, male students created more metaphors for learning a new skill, the difficulties of learning mathematics and having hardship compared with female students.

Discussion

The three most commonly used metaphors were; solving a puzzle (65 students), playing a computer game (50 students) and learning the life (47 students). The metaphors associating learning mathematics to discovering the unknown, an expedition of discovery, learning the life and solving puzzle show similarity to the metaphors reported in previous studies (Allen & Shiu, 1997; Lim, 1999; Noyes, 2006; Reeder et al., 2009; Schinck et al., 2008; Wood, 2008).

It was also concluded that students created a metaphor that emphasized the hierarchical structure of mathematics; it's having a rule base, its use as an instrument and regarding mathematics as a global language. For instance, 31 students who used metaphors of learning a new language (12) and learning speaking (19) associated mathematics to a global language. Describing mathematics as a language is in parallel with the findings of Allen and Shiu (1997), Noyes (2006) and Sterenberg (2008). On the other hand, students who used metaphors of a computer game, building construction, climbing a mountain and navigating a maze, which were classified under different themes of eight conceptual categories, emphasize the hierarchical structure of mathematics. In the studies by Noyes (2006) and Schinck et al. (2008), students also touched on the hierarchical structure of mathematics.

In this study, 18 different metaphors developed by about one third of the participants for learning

mathematics were classified under the conceptual categories of learning a new skill and playing a game by learning its rules. This categorization emphasizes the necessity of learning the rules of mathematics and studying systematically. The requirement of studying mathematics systematically was also stated by students in a study by Oflaz (2011). This requirement can be regarded as a reflection of the education that students receive. In primary and secondary school mathematics education in Turkey, doing calculations using the formulas and solving routine problems are taught (memorized) to the students (Delil, 2006; Olkun & Toluk, 2002). These students regard learning mathematics as gaining the skills of solving previously stated situations (problems) by learning essential procedures (methods). As a result, Turkish students are less successful at the TIMSS test (EARGED, 2008).

Statistically significant differences were found between the metaphors that students used to describe learning mathematics according to the types of high schools. Students at Anatolian high schools mostly used the metaphors of discovering unknown and pleasure of learning mathematics, whereas students at vocational high schools mostly used the metaphors about difficulties of learning mathematics and having a hardship. No statistically significant difference was found between the categories of learning a new skill, solving a puzzle and learning the rules and playing a game according to the types of high schools.

The metaphors of suffering torture and pain, used by students at vocational high schools, indicate that these students are not happy in mathematics lesson. A male vocational high school student stated that mathematics lesson is a torture for him, pointed out to the negative effect of lack of basic mathematical knowledge on his current situation and said: "For me, learning mathematics is a torture; because I lack mathematics knowledge and I do not want to make up my deficiencies. I do not like mathematics. Mathematics is not an enjoyable lesson for me." Other studies reported similar negative attitudes towards mathematics: mathematics being a difficult and boring lesson (Güveli et al., 2011), the hardship of learning mathematics (Sterenberg, 2008) and negative statements about mathematics (Oflaz, 2011).

Examining the conceptual categories that differed according to gender, it was concluded that female students enjoyed learning mathematics and regarded mathematics as a game. On the other hand, male students associated learning mathematics with learning a new skill and emphasized the difficulties of learning mathematics. Most of the female students who enjoy learning mathematics were from Anatolian high schools. But majority of male students who say learning mathematics is difficult were from vocational high schools. These may indicate the role of high schools which students attend more dominant to students' metaphors about learning mathematics than students' gender.

A female student at an Anatolian high school stated: "For me, learning mathematics is like taking a walk in a new city together with a guide; because mathematics cannot be learned by its own. That is why there is need for a good guide." This answer emphasizes the need for the guidance of a teacher, which was also reported in the studies of Fleener et al. (1995) and Cerit (2008).

In addition, it is thought that high school teachers should receive in-service training about how students perceive learning mathematics. Teachers should know what to do to endear mathematics to students, to interest them in mathematics and to change their minds about the idea of mathematics being "torture". Moreover, it is also thought that knowing the perceptions of high school students on learning mathematics is important for the education of future teachers. Therefore, it is suggested that pre-service mathematics teachers should be educated on this issue. It is also thought that it will be beneficial for teachers to trained how to encourage students to like mathematics, to have positive manners towards mathematics and how to make mathematics more attractive.

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