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Mathematics teachers in preservice teachers' metaphors

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This study explored preservice mathematics teachers' beliefs about mathematics teachers through asking them about their metaphors for mathematics teachers. Preservice teachers' (N=249) metaphors and explanations for mathematics teacher were analysed considering the categorizations developed for the NorBa-TM project based on the extended framework of Beijaard and colleagues (2000). Most of the preservice teachers described mathematics teachers as didactics expert and through their personalities. The findings are discussed and implications for field of mathematics teacher education are presented.

Keywords: Preservice teachers, metaphors, beliefs.

INTRODUCTION

Teachers' beliefs can provide us an insight on how and/or why they teach in a certain way (Cross, 2009). Beliefs about the mathematics teacher are likely to provide information about the roles teachers might assume in the mathematics classroom and how they might enact these roles. Despite the constructivist reform in mathematics education in Turkey since 2005, many teachers continued to conduct more traditional teaching (Avçu, 2014) and many preservice teachers come to teacher education programs with beliefs developed in these classrooms. However, teacher education programs focus on more constructivist roles for preservice teachers and try to initiate related beliefs (Haser & Doğan, 2012). Understanding the image of teacher in preservice teachers' minds might provide clues about the effectiveness of teacher education programs in helping preservice teachers develop beliefs which will help them in their future career.

One way to understand preservice teachers' beliefs about mathematics teachers is to analyse their meta-

phors for mathematics teachers. The word "metaphor" derives from Greek term "metapherein" which means "to carry over" (Green, 1971). Basically, when describing something with a metaphor we somehow transfer the characteristics and experiences of one thing to another by considering the similarities between these two things (Lakoff & Johnson, 1980). Metaphors could be interpreted as blueprints of people's thought (Martinez, Sauleda & Huber, 2001) and they work as creative instruments to deeply understand a complex phenomenon when it is rather difficult to describe it (Oksanen & Hannula, 2013). Therefore, metaphors are used by researchers in order to investigate preservice and in-service teachers' beliefs about teaching and teaching environments which could be interpreted as complex constructs (Massengil-Shaw & Mahlios, 2008). Teacher identity frameworks could be helpful in analysing metaphors for teachers.

Beijaard, Verloop and Vermunt (2000) identified three distinct knowledge bases of teacher knowledge reflecting teacher's professional identity. Accordingly, teacher identity could be expressed in terms of teacher as *a subject matter expert, a didactic expert, and a pedagogical expert*. *Teachers as subject matter experts* have deep knowledge in their discipline and transmit information to their students. *Teachers as didactic experts* have knowledge on planning, implementation, and evaluation of teaching and learning process to facilitate understanding for students. *Teachers as pedagogical experts* focus on caring and nurturing students' holistic development (Beijaard et al., 2000). These three aspects of the model are connected with Shulman's (1986) ideas of teacher's content knowledge, pedagogical content knowledge and pedagogical knowledge respectively. However, teacher identity is beyond what teachers should know; rather it focuses on what teachers consider as important in their professional work (Beijaard, Meijer, & Verloop, 2004).

Löfström, Anspal, Hannula and Poom-Valickis (2010) have investigated and categorised preservice teachers' metaphors for teachers by using this model of teacher identity. They further added *self-referential metaphors* to address teachers' personality and suggested that metaphors could be labelled as *contextual* when they described characteristics of the environment teachers worked in. Metaphors including more than one characterisation in equal emphasis were considered as *hybrid*.

The above categorizations were investigated in pre-service and inservice teachers' metaphors in Finland. Findings suggested that the most frequent metaphor category referred by inservice mathematics teachers was *didactics experts* (Oksanen & Hannula, 2013; Oksanen, Portaankorva-Koivisto, & Hannula, 2014), whereas preservice teachers mostly preferred *self-referential* metaphors (Oksanen et al., 2014). This difference might be due to the way participants were asked about their metaphors; inservice teachers were asked to complete "teacher is like..." statement and preservice teachers were asked to complete "as a mathematics teacher I am...." (Oksanen et al., 2014).

The purpose of this study was to explore preservice mathematics teachers' beliefs about mathematics teachers by asking them about their metaphors of mathematics teachers. Another aim of the study was to pilot categorization of teachers' metaphors suggested by Löfström and colleagues (2010) based on Beijaard and colleagues' (2000) model.

METHODOLOGY

Context and participants

The study was conducted at Elementary Mathematics Education (EME) Programs at four Universities in Ankara, Turkey. These four-year programs train teachers for teaching middle school mathematics (grades 5 to 8) and courses are determined by the Higher Education Council (YÖK), the governing body of all universities in Turkey. Although the courses are distributed differently in programs, two-semester methods of teaching mathematics courses are offered in the third year and practice teaching courses are offered in the fourth year of the program across the universities (YÖK, 2007).

A total of 249 preservice teachers were accessed at the end of the spring 2014 and 226 of them (33

male, 193 female) were the participants of this study. Participants were 3rd year (123) and 4th year (103) pre-service teachers because they were the participant group relatively close to the mathematics teaching profession. Differences in metaphors due to year level in the programs were not the focus of the study.

Data collection and instruments

The study was a part of a more comprehensive international comparative study NorBaTM (New Open Research: Beliefs about Teaching Mathematics, formerly known as NorBa) conducted in over 15 countries in order to investigate mathematics teachers' beliefs. The questionnaire used for the present study was elaborated from the more comprehensive scale used in NorBaTM study.

The metaphor questionnaire was composed of three parts. In the first part, participants' age, gender, and year level in the EME programs were asked. Then, a brief description of the word "metaphor" was provided as a way of describing a concept by using similarities to another concept. This description was given because the participants might not be familiar with the term "metaphor" or what it actually meant. A similar word used in Turkish language was also reminded. In the second and third parts, participants were asked to describe mathematics teacher and mathematics teaching respectively through metaphors and explain their metaphors. In this paper, their responses to the following statement are reported: "Mathematics teacher is like Because,"

Researchers contacted the EME Programs at participating Universities, after necessary ethics permissions were granted. They were allowed to collect data towards the end of classes. Pre-service teachers who were at the provided place of data collection (classes) at the time of data collection were surveyed by the questionnaire. They were informed about the study by the researchers and given 20 minutes to complete the questionnaire.

Data analysis was performed by employing the categorization explained below through a manual developed for the NorBa project (Löfström, Poom-Valickis, & Hannula, 2011). First, all three researchers carefully read and discussed about the metaphor categorization. Then, a randomly selected 20% sample of data was coded by the researchers individually. Researchers compared their codes and discussed about the mi-

nor differences in coding. This process helped the researchers to make more sense of the categorization and the possible examples in data for these categories. This pilot coding was completed with almost 100% agreement. Then, all data were coded by the researchers individually through the specified categorization. Three researchers compared their coding of data case-by-case. A total of 23 cases including 5 no-response, 9 invalid (cases which researchers could not code), and 9 undecided (cases which researchers could not agree on the final categories) cases were removed from the data. Remaining 226 cases were considered as the data of the study. The disagreements that appeared during the comparison of researchers' coding were discussed to avoid over-interpretation of the explanations.

RESULTS

Distribution of metaphors used by preservice mathematics teachers is presented in Figure 1 below. While the didactics (29.6%) and self-referential (26.5%) categories were seen as the highest categories, only a small portion of the participants preferred to use contextual metaphors (2.2%).

Teacher as didactics expert (29.6%)

Teacher as didactics expert was the most frequent metaphor in the current study. Preservice teachers in this group mostly described mathematics teacher as a guide who assisted students to discover and under-

stand the world of mathematics, and helped students when they had difficulty in mathematics, with metaphors such as guide (3 times), light (2 times), candle, star, and map. Participants also mentioned that mathematics teacher used different ways and methods to facilitate mathematical learning of students. For instance, one participant considered a mathematics teacher like an enzyme:

Mathematics teacher supports students to discover mathematical ideas through questioning, making inferences and evaluations. Like an enzyme in chemical reactions, a good mathematics teacher can facilitate the mathematical learning of students, whereas a bad mathematics teacher might cause to slow down this learning process.

Some of the preservice teachers who emphasized the importance of using different methods also described mathematics teacher as a creative artist who performed different roles in a mathematics lesson in order to gain attention of students and implement non-routine mathematics instruction.

Another common characteristic for mathematics teachers was providing a basis for students' mathematical knowledge. Preservice teachers who stressed this issue generally associated mathematics teaching with constructing a building:

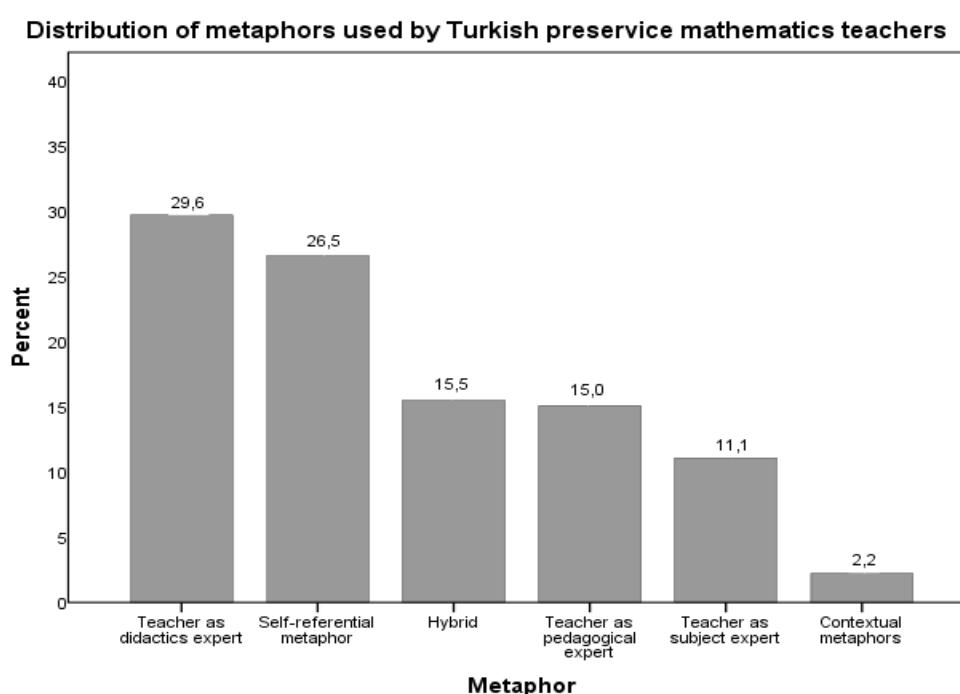


Figure 1: Distribution of metaphors used by the preservice mathematics teachers

Mathematics teacher is like a contractor. If a contractor uses high quality material and properly constructs the base, the building becomes strong. Similarly, if a teacher teaches the topics by enabling meaningful learning instead of rote learning, students' mathematical knowledge becomes strong.

Self-referential metaphors (26.5%)

In self-referential metaphors, there was an emphasis on mathematics teachers' characteristics which were not related with teaching or mathematics teaching profession. Some of these metaphors were used to appreciate mathematics teachers, whereas some to criticize them. Common positive characteristics of mathematics teachers were stated as being smart, hardworking and practical. Some metaphors describing these positive characteristics were an ant (often used to describe hard working people in Turkish culture), small house appliances, and human brain. Participants appreciated mathematics teachers by stating that mathematics was difficult and only smart people could do mathematics.

Surprisingly, some preservice teachers mentioned mathematics teachers' negative characteristics by portraying them as insensitive machines such as robots or computers. Often, they were not friendly with students:

Mathematics teacher is like a gravestone. They get tough with the class and do not ever smile.

Some other negative characteristics attributed to mathematics teachers were being arrogant and scary. These negative characteristics were rather stated as how mathematics and mathematics teachers were perceived by students:

Mathematics teacher is like a doctor. A child who is afraid of getting a shot does not like the doctor. [Similarly,] when a student does not like mathematics, s/he does not like mathematics teacher. When s/he is afraid of mathematics, s/he is also afraid of mathematics teacher.

Participants also frequently stressed that mathematics teacher should be patient while teaching mathematics, which was a difficult job. Patience stone (a phrase used to describe a very patient person in

Turkish culture, 3 times) and gardener (2 times) metaphors were used to emphasize this characteristic.

Hybrids (15.5 %)

Hybrids were metaphors including more than one category. The most common category in hybrids was didactical expert (27 times). Didactical expert category was generally expressed together with subject expert (11 times), pedagogical expert (10 times) and self-referential (9 times) categories. The following metaphor included both didactics and subject expert aspects:

Mathematics teacher is like a chess player. For a chess player, it is not enough to know how each chessman moves. The player also needs to know how to develop tactics to win the game. Similarly, mathematics teacher needs to know all of the details of the topics and apply this knowledge to the lesson considering the students' needs and backgrounds.

Another observable issue about hybrids was that the number of hybrids including contextual elements (7/35) was more than the uniformed contextual metaphors (5/191). It seemed that preservice teachers preferred to use contextual elements by considering other characteristics of a teacher.

Teacher as pedagogical expert (15%)

Preservice teachers who stated metaphors in this category generally mentioned the guiding mission of mathematics teachers in students' lives. Mathematics teachers should support the development of students as human beings and thus, they should enlighten students' lives such as the sun (3 times), light, lighthouse, and pole star. For instance, one participant portrayed the mathematics teacher as the sun and the moon:

Mathematics teacher enlightens his/her students. S/he tries to guide them and helps students to realize the things around them. Then, s/he observes what they can do by themselves. This is the time when mathematics teacher is like a moon. S/he does not leave them alone, s/he supports them like how moon looks after the night.

Another common issue was the caring and nurturing characteristics of mathematics teachers where they were described as merciful and helpful. Metaphors

for the caring characteristics were mother (3 times) and father.

Teacher as the subject matter expert (11.1%)

Preservice teachers who described mathematics teachers as subject matter experts generally focused on two characteristics of mathematics teachers: (i) being knowledgeable and (ii) performing operations without making mistakes.

In the first group, there was a clear emphasis on the knowledge of mathematics teachers as indicated by metaphors such as book, journal, and encyclopaedia. In these metaphors, mathematics teachers were characterized as having accurate knowledge of mathematics similar to a book. Some participants indicated that a mathematics teacher was not only knowledgeable in mathematics, but also knowledgeable in the other content.

In the second group of metaphors, there was an emphasis on the calculation skills of mathematics teachers. Mathematics teachers could successfully perform operations and solve problems in a short time without making mistakes. Metaphors such as smart phone, calculator, and computer were stated:

Mathematics teacher is like a calculator. A mathematics teacher should perform operations very efficiently otherwise, s/he might be interpreted as weak. S/he is expected to answer questions immediately.

Contextual metaphors (2.2%)

In the current study, only five preservice teachers uniformly mentioned the contextual factors while describing mathematics teachers with metaphors. Two of these preservice teachers focused on what it meant to be a mathematics teacher in Turkey. They indicated that it was difficult to be a teacher and a mathematics teacher in Turkey, and it was not appreciated enough:

Mathematics teacher is like a slave. Because, a teacher has no value in this country. Furthermore, it is not a well-paid profession and thus, I just consider him/her as a slave.

Another stressed issue was related with how mathematics was seen in the society. Negative bias and fear of mathematics were the main foci:

Mathematics teacher is like a bogey. In our country, teachers shout and get mad at students. According to my observations, students are especially scared of the mathematics teacher.

DISCUSSION AND CONCLUSIONS

What do these metaphors tell us? They seem to address that preservice middle school mathematics teachers prioritize didactics knowledge and skills when they consider a mathematics teacher as evidenced in their *didactics expert* and *hybrid* metaphors. For the Turkish context, the frequent reference to *didactics expert* might be a reflection of the courses on mathematics teaching and learning offered in the 3rd and 4th year where the guiding characteristic of mathematics teachers for students' learning was emphasized. EME programs had a major change in 2006 and the number of pedagogical content knowledge courses were increased without decreasing the number of mathematics content knowledge courses. A study conducted in the previous version of the EME program with less number of pedagogical content knowledge revealed that preservice teachers mostly believed that a mathematics teacher should have mathematics content knowledge, then pedagogical content knowledge, and then pedagogical knowledge (Haser & Doğan, 2012) in Shulman's (1986) terms. This corresponds to being *subject expert*, then *didactics expert*, and then *pedagogical expert* in the current study. Considering these findings, we cautiously speculate that the emphasis on pedagogical content knowledge courses in the last two years of the EME programs might affect preservice mathematics teachers' metaphors towards *didactics expert*. However, since we did not collect data from 1st and 2nd year students, we do not have information about preservice teachers' metaphors in the first two years of the program and this interpretation is very limited. On the other hand, Finnish preservice teachers described teachers mostly by their personality (*self-referential* metaphors) when they were asked in a rather personalized or subjective way (Oksanen et al., 2014), which could be the case in Turkish context if we had asked in a personalized way.

Preservice mathematics teachers who described a *subject matter expert* mostly emphasized procedural knowledge of mathematics rather than conceptual knowledge. Preservice mathematics teachers in EME programs have been reported to have both constructivist and traditional beliefs about the nature of

mathematics (Kayan, Haser, & Işıksal, 2013). It seems that metaphors provided a different window for us to gain more knowledge about beliefs that preservice teachers might have carried from their precollege education.

Self-referential metaphors were stated mostly in relation to mathematics. Being a mathematics teacher was valued by emphasizing that teaching mathematics required being hardworking, smart, and patient. Surprisingly, some participants criticized mathematics teachers for being rather unfriendly and scary. It was not clear whether participants described the mathematics teachers in the eyes of the students or society, or what a mathematics teacher meant for them in their explanations. Therefore, what these metaphors communicated in terms of preservice teachers' beliefs about mathematics teachers remained inconclusive.

Oksanen and colleagues (2014) state that *hybrid* metaphors might reflect the complexity of the teaching profession. *Hybrid* metaphors might provide information about how different sides of the mathematics teaching profession are internalized and integrated. We argue that the effectiveness of teacher education programs might be traced by the *hybrid* metaphors that preservice teachers could develop. If preservice teachers would be able to explain their metaphors by referring to different types of teacher characteristics, could this be a reflection that they have developed a more comprehensive image of a mathematics teacher in their minds? This might be an issue for a further discussion and research in which preservice teachers' metaphors could be investigated through their studies in the teacher education programs and also based on the nature of the programs.

Contextual metaphors were the least mentioned metaphors in this study. This could be a reflection of the insufficient school experience in teacher education programs. Preservice middle school mathematics teachers spend 4 hours per week in the first semester and 6 hours in the second in their senior year in the program. This experience focuses on observing and generally includes 1 or 2 hours of teaching for the whole year. Therefore, they might not be experiencing the contextual elements about being a teacher as inservice teachers do. However, Finnish inservice teachers also did not state *contextual* metaphors much (Oksanen & Hannula, 2013). Yet, it might be the case that crowded classrooms and lack of sufficient

instructional materials in Turkish schools (OECD, 2009) could result in more *contextual* metaphors if the study had been conducted with inservice teachers, compared to the Finnish case.

Using metaphors to gain insight about preservice teachers' certain beliefs also revealed evidences about other beliefs. Preservice teachers stated beliefs about the nature of mathematics in their explanations. Many explanations referred to society's views about the nature of, teaching, and learning mathematics. It seemed that asking metaphors might offer more or other than what was intended in the beginning. Asking specific experiences, significant person, or events that have caused to state their metaphors could provide more windows into participants' mathematics related beliefs.

The metaphor framework based on Beijaard and colleagues (2000) model was effective in analysing Turkish metaphor data in this study. The eliminated data were difficult to conclude on a category due to the content they included. It should be noted that Turkish data for metaphors do not reveal participants' gender preferences (unless asked) in referring to a teacher because Turkish language does not have gender difference in referring to a person.

Certain limitations should be considered in making sense of the findings of this study. First, written data might not be as detailed as verbal data. Interviews conducted on these metaphors could have provided more insight into preservice teachers' beliefs about mathematics teacher. Participants might have written more about their explanations if they had been given more time.

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