

Candidate Primary School Teachers' and Primary School Teachers' Metaphorical Perceptions about Teaching and Mathematics Teaching

Aysel Ferah Özcanⁱ
Sakarya University

Abstract

The primary goal of this study is to identify the metaphors primary school teachers and candidate teachers use to describe teaching and mathematics teaching. The second goal is to highlight the parallels and discrepancies between metaphoric themes related to teaching and those related to mathematics teaching. A study in phenomenological design—one of the qualitative research methods—was conducted with this goal in mind. The study involved 121 primary school instructors and 84 undergraduate primary school teaching students. The researcher's own questionnaire form was used to electronically gather the data. After conducting a content analysis of the data, themes were developed. Four (4) themes for candidate teachers and six (6) themes for teachers were created from the metaphors provided for the concept of teaching. Six (6) themes for instructors and four (4) topics for potential teachers were created from metaphors about mathematics teaching. It is believed that certain teaching metaphors and metaphors for mathematics teaching are influenced by prior knowledge, some by teaching material, and some by experience. The fact that the teachers—as opposed to the candidate teachers—created metaphors about mathematics teaching around the themes of "A Field of Instruction with Rich Solutions" and "A Field that Requires Variety in Teaching Methods and Techniques"—suggests that teachers' opinions on the subject evolve as they gain more practical knowledge. It is advised that prospective primary school teachers be offered training in related courses to help them form views about teaching and mathematics teaching in light of the research's findings.

Keywords: Teaching; Mathematics Teaching; Teacher Training; Primary School Teaching; Perceptions of Teaching and Mathematics Teaching

DOI: 10.29329/ijpe.2023.579.4

Submitted: 19/02/2023

Accepted: 19/07/2023

Published: 01/08/2023

ⁱ **Aysel Ferah Özcan**, Instructor Dr., Faculty of Education, Department of Basic Education, Sakarya University, ORCID: 0000-0002-9196-4838

Email: aferah@sakarya.edu.tr

INTRODUCTION

Arithmetic, which deals with numbers and rules for dealing with them, and geometry, which deals with problems of surface and surface measurement, have long been associated with mathematics as the science of quantities and space (Davis & Hersh, 1980). In truth, algebra, arithmetic, and problem-solving are all parts of mathematics (Bruning, Schaw, & Norby, 2014). The environment and practical information obtained in other study areas are covered in mathematics instruction today (Schunk, 2009). Based on their prior knowledge of mathematics from their undergraduate education, teachers who will teach mathematics are prepared with specialized teaching topic knowledge. The teaching and learning course serves as the foundation for the mathematics teaching course as well. In the literature, it is thought that teachers and candidate teachers have a mental schema for mathematics teaching and teaching concepts. In this article, the meanings that teachers and candidate teachers attribute to the concepts of mathematics teaching and learning were tried to be determined with the metaphors they produced.

Mathematics Teaching and Teacher Training

Mathematics teaching is a course in which children acquire mathematical knowledge and skills. Specialization in mathematics occurs through children's acquisition of conceptual and methodological knowledge and skills (Rittle-Johnson & Star, 2009). Therefore, in studies where the basic issues of learning are associated with the mathematics learning domain, the development of mathematical skills in children, the use of teaching strategies, cognitive-affective factors affecting mathematics learning, etc. have been focused on (cf. Desoete, Ceulemans, De Weerd, & Pieters, 2010; Landerl & Kölle, 2009; Siegler, Robinson 1982; Vanbinst, Ceulemans, Peters, Ghesquière, & De Smedt, 2018; Vanbinst, Ghesquière, & De Smedt, 2015). Research shows that children's numerical processing skills develop before their arithmetic skills (Barteler, Vaessen, Blomert, & Ansari, 2014; Vanbinst, Ghesquière, & De Smedt, 2015). It is a well-known fact that teachers need to have the pedagogical content knowledge to develop children's mathematical knowledge and skills correctly and effectively. Pedagogical content knowledge is teacher-specific knowledge and the combination of teachers' subject matter knowledge and pedagogical knowledge includes pedagogical content knowledge (Cochran, DeRuiter, & King, 1993). It has been stated that teachers' mathematical knowledge and pedagogical content knowledge are vital for effective mathematics teaching and children's learning (Walshaw & Anthony, 2007). This issue is related to the field of teacher education.

In Turkey, primary school teachers teach children mathematics lessons for four years of primary school. These teachers graduate from universities by taking mathematics-related teaching courses in the undergraduate programs of primary teaching in faculties of education. *When the content of the mathematics teaching course of the programs that train primary school teachers in Turkey is examined, it is seen that mathematics as a historical process, special teaching methods and techniques, learning and teaching theories, and its place in mathematics teaching as a special teaching field, problem-solving, information technologies, number concept and its development in children, mathematics curriculum, mathematics subjects, development and teaching of concepts such as geometry-measurement-number-time, etc. in children, measurement and evaluation of success, learning misconceptions* (YOK, 2019). Therefore, to be able to teach mathematics, candidate teachers should have knowledge and skills in the mathematics special field, learning-teaching content knowledge, curriculum, and development of numerical processing skills in children.

In reality, mathematics teaching is a complex task involving many factors and is envisioned as a course of reflection and cognitive operations (Bruning, Schaw, & Norby, 2014). Candidate elementary teachers bring to their professional work some prior content knowledge about teaching and learning mathematics, pedagogical experiences, and experiential thinking embedded in their epistemological orientations (Wilcox, Schram, Lappan, & Lanier, 1991). Candidate teachers have some deep-rooted beliefs about mathematics teaching and learning before they start taking a mathematics teaching course; they may also acquire new ways of thinking about teaching and learning through a mathematics teaching course (Ball, 1990; Wilcox et al., 1991). It is thought that

metaphorical discourses used in mathematics courses can also affect students' epistemological beliefs about mathematics (Olsen, Lew, & Weber, 2020). It can be expected that primary school teachers' perceptions about teaching and mathematics teaching will be shaped by their undergraduate education and professional experience. Positive perceptions may be reflected in teachers' attitudes toward mathematics teaching (Tarım, Özsezer, & Canbazoglu, 2017).

Teaching

One of the pedagogical concepts necessary for mathematics teaching is the concept of teaching. Because mathematics teaching practices in the classroom affect students' learning (Hiebert & Grouws, 2007). The concept of teaching refers to the process of attending to people's needs, experiences, emotions, and intervening to help them learn certain things and go beyond what is given. The importance of teaching stems from the fact that how a teacher understands it affects his/her actions in the classroom (Hirst, 1971). Although candidate teachers are provided with field-based training during their university education, they may have concerns about transferring theories into practice (Harding & Hbaci, 2015). It has also been determined that candidate teachers have strong beliefs about learning and teaching that can be an obstacle to teaching and that teaching interventions can change the beliefs of candidate teachers, especially those who are prejudiced against teaching (Joram & Gabriele, 1998). Similarly, many actions of teachers in the classroom are the result of many components such as content knowledge, teaching practices, beliefs, and experiences (O'Sullivan, MacPhail, & Tannehill 2009). From the perspective of social interaction theory, teaching can be defined as the professionalization of a beginning teacher through the process of interpreting what he/she has acquired through his/her undergraduate education and teaching experience (Shaw & Mahlios, 2008). The teaching beliefs of candidate teachers and teachers can be expected to be shaped in the light of their background knowledge, the courses they take in university education, the teaching strategy knowledge they acquire in teaching courses, and the experiences they gain when they become teachers. One of the ways to understand this change may be to check the metaphors of candidate teachers and teachers about the subject.

Related Literature

When the studies in the literature are investigated, it is understood that the perceptions of candidate mathematics and primary school teachers about learning, mathematics, problem-solving, algebra, etc. are determined through metaphors. For example, candidate teachers' metaphors of the concept of mathematics (Güveli, İpek, Atasoy, & Güveli, 2011) and their perceptions of the concept of mathematics and mathematics teaching (Tarım, Özsezer, & Canbazoglu, 2017) are the subjects that have been studied. For candidate teachers, mathematics course metaphors (Güner, 2013), attitudes, and metaphors towards the concept of mathematics (Kuzu, Kuzu, & Sivacı, 2018) have also been studied. For example, Tarım et al. (2017) determined that mathematics teaching metaphors of classroom teaching candidates were gathered in five themes: *indispensability, infrastructure/resource, motion, labor/effort, and desire/emotion*. In a study in which mathematics teacher candidates who received pedagogical formation certificate training participated, it was determined that half of the participants had a negative perception of teacher training (Sener, Bulut & Unal, 2017). The results of a study conducted by Sahin (2013) showed that pre-service science and classroom education teachers produced more positive metaphors for mathematics. Pre-service teachers studying in social fields, on the other hand, associated the concept of mathematics with the metaphors of difficulty and necessity.

In a study, it was determined that the majority of teachers saw *teaching and learning* as knowledge transfer, a small group as constructivist, and a smaller group as a social process (Martinez, Sauleda, & Huber, 2001). Ural, Aydemir, Toker-Gökçe, and Öztoprak-Kavak (2016), in a study investigating the perceptions of secondary school students and teachers towards teaching and their metaphorical perceptions of teaching, found that teachers' metaphors about teaching were gathered under the themes of *discovering the gem, futile work, effort and endeavor, and a fun job*. According to the results of the same study, students' metaphors about the concept of teaching are similar to those of their teachers.

For the concept of teaching, there are metaphor studies with secondary school students, teachers and teacher candidates (see. Çetinkaya and Eskici, 2018; Martinez, Sauleda, & Huber, 2001; Sadi, 2014; Ural, Aydemir, Toker-Gökçe, and Öztoprak-Kavak, 2016). In some of these studies, it has been determined that both teacher candidates and most of the teachers have produced metaphors that see teaching as a knowledge transfer process (see. Çetinkaya and Eskici, 2018; Martinez et al., 2001). In addition, it was also observed that candidate teachers' teaching metaphors and teaching metaphors differed to a great extent, their beliefs on these issues were diverse, and in some prominent themes, these metaphors could be handled together (Martinez et al., 2001). Eren and Tekinarslan (2013), one study, it was concluded that the concepts of teaching and teaching material, learning, and evaluation were also related. For this reason, they stated that it was natural that the metaphors produced by candidate teachers for these four concepts were also related to each other. In a study by Shaw and Mahlios (2008), it was concluded that teacher candidates' teaching metaphor themes could be compared with dominant literacy themes, and that teaching and literacy themes varied.

Current Study

Metaphors are not only language tools but also basic cognitive tools that enable people to make sense of the world around them and are used to associate abstract ideas with concrete experiences (Godor, 2019; Wegner, Burkhart, Weinhuber, & Nuckles, 2020). It is possible to learn people's perceptions about concepts, knowledge, skills, actions, etc. through metaphors. Therefore, research has focused on metaphors to reveal the meanings that candidate teachers' or teachers' attribute to various concepts. At the same time, the metaphors produced also contain information about people's beliefs. While implicit beliefs in learning and teaching can be identified through metaphors, these beliefs may differ according to being a student or a teacher and the level of education served or studied (Saban, Nazlı, Koçbeker, Saban, 2007). As a matter of fact, Tarım, Özsezer, and Canbazoglu (2017) determined that there is a lot of research on mathematics in the literature, but studies on mathematics teaching are more limited and suggested that research on metaphors, perceptions, etc. for teachers and candidates should be included more.

As explained in the conceptual framework given above, one of the fields related to mathematics teaching is the field of learning-teaching. For this reason, addressing teaching and mathematics teaching metaphors together will enable a more comprehensive explanation of the subject. There is a need to know how candidate teachers and teachers perceive and define mathematics teaching and mathematics teaching. To the best of our knowledge, metaphorical studies dealing with the concepts of teaching and mathematics teaching together are limited in the literature. Only one study was found in the literature that associated teaching with a specific content area (primary literacy teaching) (Shaw & Mahlios, 2008). In line with the conceptual framework explained above, in this study, it was determined that the pre-service teachers and teachers' metaphors of teaching and mathematics teaching were not investigated together as a problem situation. For this reason, the first aim of this study is to determine the metaphors of candidate and primary school teachers towards the concepts of teaching and mathematics teaching. The second purpose is to determine the perceptual differences/similarities between the themes of teaching and mathematics teaching metaphors. In line with the aforementioned purpose, in the research, "*1. What are the teaching and mathematics teaching metaphors of candidate and primary school teachers? 1.a. What are the teaching metaphors of candidate? 1.b. What are the teaching metaphors of primary school teachers? 1.c. What are the mathematics teaching metaphors of candidate? 1.d. What are the mathematics teaching metaphors of primary school teachers? 2. Are the metaphor themes of candidate and primary school teachers' metaphors of teaching and mathematics teaching similar?*" questions were tried to be answered.

Determining the metaphors of teachers and candidate teachers about teaching and mathematics teaching is important for several reasons. First, mathematics teaching is built on the concept of teaching as in all teaching fields. In this way, it will be possible to understand how teaching in general and mathematics, in particular, are associated with the specific subject of teaching. Secondly, by examining both concepts and the metaphors of candidate and primary school teachers together, detailed information about the perceptions of the concepts before and after service will be obtained.

By comparing teachers and candidate teachers, it will be determined whether teacher education and professional experience change the conceptual framework for teaching and mathematics teaching. Thirdly, by determining this conceptual framework, some conclusions can be reached about both candidate and primary school teacher training for mathematics teaching. Finally, by associating mathematics teaching metaphors with mathematics course content and determining whether the metaphors produced reflect content knowledge, the efficiency of mathematics teaching courses will be mapped.

METHOD

Study Model

The phenomenology design, one of the qualitative research approaches, was used in this study to ascertain the metaphorical perspectives of primary school teacher candidates and primary school teachers regarding teaching and mathematics teaching. A qualitative research method known as "phenomenology design" is used to describe how people perceive a phenomenon. It helps to disclose people's viewpoints, experiences, and perceptions of a phenomenon, event, or concept (Rose, Beeby, & Parker, 1995). How prospective elementary school teachers and current elementary school teachers view teaching and mathematics instruction is the phenomenon that this study addresses.

Study Group

The study group for this research was chosen using the convenience sampling approach. The research was carried out with classroom teachers and teacher candidates. Teacher participants work in various cities of Turkey. Student participants are students studying in the classroom teaching department of a university. The non-random sampling method known as convenience sampling saves the researcher time and money (Birks & Malhotra, 2006). 84 prospective teachers and 121 current teachers participated in this study. The study's participants were assigned the codes A1, A2,....A; T1, T2,..... based on ethical criteria. Direct quotes from the participants were also cited in conjunction with these codes. Table 1 lists the demographic details of the study group's participants.

Table 1. Demographic Information of the Candidate Primary School Teachers and Primary School Teachers in the Study Group

Primary School Teacher			Total	Candidate Primary School Teacher			Total
Gender	Female	93	121	Gender	Female	65	84
	Male	28			Male	19	

As seen in Table 1, 121 of the research participants were teachers and 84 were candidate primary school teachers. Of the teacher participants, 93 were female and 28 were male. On the other hand, 65 of the candidate teachers were female and 19 were male.

Data Collection Tool

The data of this study were collected in an electronic form created by the researcher. In the first part of the form, demographic information of the participants such as age, seniority, and grade level, and in the second part of the form, to determine the teaching and mathematics teaching metaphors of candidate elementary school teachers and elementary school teachers, "*Teaching is like Because.....*" and "*Mathematics teaching is like Because.....*" expression structures were included.

Data Collection

The "Form of Primary School Primary school teachers' and Candidate Primary school teachers' Metaphors for the Concepts of Teaching and Mathematics Teaching" prepared by the researcher via Google, which includes the purpose of the research, voluntary consent for participation

in the research, and demographic data of the participants, was used to collect the data for this study. The study's participants received electronic versions of the forms outlining the study's objectives, requesting their consent to participate in the study, and collecting demographic data. The metaphors that teachers and candidates for the position of teachers created and electronically wrote, along with the justifications for these metaphors, were transformed into a Word document. The tabular data produced a 22-page written report.

Data Analysis

The research data were analyzed by content analysis method. In content analysis, concepts are classified and the subject is described with more abstract and general themes (Merriam & Grenier, 2019). The metaphors of teaching and mathematics teaching produced by the candidate primary school teacher and primary school teacher participants, the reasons for the metaphors, and the meanings they express were examined in depth and detail and coded. Each code obtained was analyzed and theme-determination processes were carried out. The reasons for the metaphors were examined and the appropriate themes were determined. Teaching metaphors were divided into four (4) themes for candidate primary school teachers. For the primary school teachers, it was classified in six (6) themes.

Mathematics teaching metaphors were divided into four (4) themes for candidate primary school teachers. For the primary school teachers, it was classified in six (6) themes. The statements of candidate teachers and teachers with different perspectives on the concepts of teaching and mathematics teaching were grouped under different themes, and examples of these statements are given as direct quotations in the findings section. For similar metaphors such as light and candle, the written explanations of the metaphors were carefully examined and analyzed in depth. According to their explanations, such similar metaphors were included in different themes. In this way, the reliability of the research was tried to be increased. In addition, the metaphor themes of teaching and mathematics teaching were compared and it was determined whether they were similar or different. In addition, the author of the study received coding support from a field expert researcher. The metaphors of teaching and mathematics teaching of candidate teachers and teachers were distributed to the themes independently by the author of this study and a field expert and the analysis was conducted again. At the end of these two analyses, the agreement between the researchers was evaluated with the formula " $Reliability = \frac{Agreement}{Agreement + Disagreement}$ " created by Miles and Huberman (1994), and the percentage of agreement between the researchers was found (87%). Since the percentage of agreement obtained is above the critical value of 70% (Miles & Huberman, 1994), it can be said that the interrater agreement is sufficient and the findings obtained are reliable.

Ethics Committee

The study was applied to the University Social and Human Sciences Ethics Committee and the necessary ethics committee approval was obtained with the date 08.07.2021 and number E-61923333-050.99-43087.

FINDINGS

In this part of the study, the metaphorical perceptions of candidate primary school teachers about teaching are tabulated and presented. Within the scope of the research's first question, the teacher candidates' teaching metaphors were examined first.

Table 2. Candidate Primary School Teachers' Metaphors of the Concept of "Teaching"

Theme	Metaphors(f)	Frequency
Developing, Useful, Infinite Knowledge Process	Light(3), planting seeds in open soil(1), irrigation(5), family(1), water(1), sun(6), road(1), plane tree(1), growing trees(1), diamond(1), shaping the soil(1), ocean(1), turning big gears(1), making flowers bloom(1), touching human life(1), building construction(1), breathing(1), planting seeds(2), lighthouse(1), flower garden(1), to illuminate(1), to light a torch(1), to candle(4), to puzzle(1), to seed(1), to shed light(1), to universe(1), to map(1), to grow a sapling(1), to compass(2), to weave a carpet(1), to live(1), to book(1), to plant a sapling(1), to paint on canvas(1), to stars(1), to seed(1), to light(3), to sky(1), to keep alive(1)	57
Mutual Impact Process	Student(1), shopping(1), learning(1), sculpting(1),	4
Process of Discovering Talents-Individual Differences	Pulling the thick blanket over the pupil (1), pomegranate (1), every grain of sand on the beach (1), painting (1),	4
Teacher Qualification (A Process Requiring Love, Effort, and Labor)	To love (2), to construct a building (1), to guide (1), to motherhood (1), to blow up a balloon (1), to strive within certain limits and possibilities (1), to grow plants (1), to grow flowers (3), a flower in a pot (1), to weave a carpet (1),	13

Out of 84 metaphors produced by candidate teachers for the concept of "teaching", 78 of them were considered valid. Table 2 shows the metaphors that candidate teachers created for the concept of teaching. When Table 2 is examined, it is understood that the metaphors produced by candidate teachers for the concept of "teaching" are grouped under four (4) themes: "Developing, Useful, Infinite Knowledge Process" (f=57), "Mutual Impact Process" (f=4), "Process of Discovering Talents-Individual Differences"(f=4) and "Teacher Quality (A Process Requiring Love, Effort, and Labor)"(f=13). According to the frequency values of the themes, candidate teachers produced teaching metaphors mostly for the themes of "Developing, Useful, Accumulative, Infinite Knowledge Acquisition Process" and "Teacher Quality (A Process Requiring Love, Effort, and Labor)". Excerpts of the metaphors produced by candidate teachers for the concept of "teaching" are given below.

Developing, Useful, Infinite Knowledge Process

to keep alive Metaphor: "Because life as a whole is a learning process" (C81)

Mutual Impact Process

Sculpting Theme: "if we think of the student (primary school) as an unformed sculpture, as we learn something, behaviors, and knowledge begin to form and take shape, while the teacher learns the subtleties of sculpture, and the student-teacher works interactively" (C75).

The Process of Discovering Talents-Individual Differences

The metaphor of pulling the thick veil over the student: "Children already have all kinds of knowledge and the potential to put it into practice. The only thing that teachers need to do is to reveal their potential and make them realize that real life is beyond the veil - beyond the school walls" (C12)

Teacher Qualification (A Process Requiring Love, Effort, and Labor)

Production Metaphor: "It requires labor, patience, energy" (C79)

The metaphor of Weaving a Carpet: "Teaching requires patience like weaving a carpet, and a carpet that is started to be woven cannot be left unfinished, that is, teaching needs to be completed properly, not left unfinished. This depends on the characteristics of the teacher." (C17)

Within the scope of the research's first question, the teachers' teaching metaphors were examined secondly. The 121 metaphors produced by primary school teachers for the concept of

"teaching" were analyzed and themes were determined for 113 metaphors that were found to be valid. The metaphors produced by teachers for the concept of "teaching" are given in Table 3.

Table 3. Primary school teachers' Metaphors of the Concept of "Teaching"

Theme	Metaphors (f)	Frequency
Teacher Qualification	Water 1), cooking, seed (1), cook(1),seed(f=1), building(1), field, writing on paper(1), cooking(1), soil-water-sun that gives life to seedlings(1), integrating,(1), building(1), planting seeds(1)	11
Mutual Interaction Process	to learning(1), flower opening in the mind(1), being a student(1), life(1), child(1), explorers' journey(1), learning(1)	7
An Emotionally Rich, Productive Action	Love(3), candy(1), joy(1), exhaustion(1), hope(1), chocolate(1)	8
Process of Discovering Talents-Individual Differences	Milky Way(1), opening locked doors(1), finding the gems in children(1), swimming, rainbows(1), pottery making(1), opening new paths in the minds of others(1), ebru(1)	8
A Necessary-Cumulative Process	Puzzle(6), growing flowers(7), success(2), growing seedlings(9), birth(5), non-fabricated crops(1), white snow(1), sowing seeds(1), saturation(1), mountain peak(5), uphill(1)	39
The Job of Providing Useful Information and Guidance to People	Candle(4), illumination(3), oil lamp(1), river(1), light(5), candle,sunlight(1), sea(1), rain(1), sunlight(1), diamond(1), pottery(1), lantern(1), scientific discovery(1), treasure box(1), light scattering, reflection(1), light scattering(1), lighting ahead(1), tree(1), tea(1), space(1), generating, breathing(1), saving lives(1), conducting(1), balloon inflation(1), guide(1), writing on a blank blackboard(1), drawing a Picture(1), touching(1), brightness(1)	40

As can be seen in Table 3, the metaphors produced by candidate teachers for the concept of "teaching" were collected under the themes of "*Teacher's Quality (f=11)*", "*Mutual Impact Process (f=7)*", "*An Emotionally Rich, Productive Action (f=8)*", "*A Process of Discovering Talents-Individual Differences (f=8)*", "*A Necessary-Cumulative Process (f=39)*", "*The Job of Providing Useful Information and Guidance to People (f=40)*". Primary school teachers produced metaphors for the concept of "Teaching" mostly in the themes of "Providing useful information and guidance to people (f=40)" and "An Important-Necessary-Cumulative Process (f=39)". It can be said that teachers tend to see teaching as an important, necessary, and cumulative process of giving useful information and guidance to people. Examples of metaphor quotations for the concept of "Teaching" produced by teachers are given below:

Teacher's Qualification

The metaphor of writing on paper: "The students get what you give them. The teacher should know so that he/she can teach" (T37).

Mutual Impact Process

The Explorers' Journey Metaphor: "It allows discovering new aspects of information that is thought to be previously learned and understood. When teaching something to someone, it allows the information taught to be better learned by the teacher and to have details that they could not discover, if any." (T97)

An Emotionally Rich, Productive Action

Love "If the teacher loves the process, he/she embraces it, the more he/she teaches, the more he/she wants to teach, and he/she enjoys his/her work." (T67)

Process of Discovering Talents, Individual Differences

Marbling: "Each color represents a child" (T106).

A Necessary-Cumulative Process

Construction Metaphor: "Knowledge is taught over a period of time and added one on top of the other". (T27).

Mountain Peak metaphor: "You experience difficulties to teach, you start from the bottom, but in the end, you reach the summit with success. You are rewarded for your efforts". (T84).

The Job of Providing Useful Information and Guidance to People

Lantern Metaphor: "You show the way". (T47)

Within the scope of the first question of the research, the metaphors of candidate teachers about teaching mathematics were examined. The metaphors produced by candidate teachers for the concept of Mathematics Teaching are presented in Table 4.

Table 4. "Mathematics Teaching" Metaphors of Candidate Primary school teachers

Theme	Metaphor (Frequency)	Frequency
A teaching field with no end of basic usefulness	Life (6), processes (1), water (1), training (2), raising warriors (1), teaching how to walk (2), the branch that helps all areas of life (1), the stars (2), the rhythm of our heartbeat(1), nature(1), the ear(1), to coding(1), eternity(2), solving riddles(1), the key(3), finding a friend(1), a life form in the ocean(1), fishing(1)	29
A teaching field with rules, stages, order	Game (3), jigsaw puzzle (3), number puzzle (1), wall (1), embroidery (1), car (1), puzzle (2), crossword puzzle (3), helping a baby to talk (1), giving a recipe (1), dominoes (1), finding the way with a compass (1), lace covering(1), dancing in harmony with numbers(1), cooking(1), lace knitting(1), dancing with numbers(1), arguing, building a wall(1), erecting a building(1), making sense of mathematics(1), nature(2), solving a Rubik's cube(1), Untangling a tangled thread(1), tracing(1), circling(1), grocery book(1), saving money in the bank(1), raising a child(1), difficult(1), a rutted road(1), a bottomless pit(1), waiting in traffic(1), tying knots(1), solving puzzles(1), a desert island(1), a bottomless pit(1)	30
An abstract-difficult, complex teaching field	Game(4), puzzle(1), passing a difficult level(1), sky(1), to the cook(1).	14
A field that is fun and requires love		8

Candidate teachers produced nine invalid metaphors about mathematics teaching. The metaphors about mathematics teaching were grouped under four themes. As seen in Table 4, candidate teachers produced the most metaphors about the concept of mathematics teaching in the theme "A teaching field with rules, stages and order" (f=30). This was followed by the theme of "A basic useful tool with no end" (f=29). Thirdly, they produced metaphors in the theme "An abstract, difficult, complex teaching field" (f=14). The last metaphor was produced in the theme "A field that is fun and requires love" (f=8). When the frequencies of the metaphors produced by candidate teachers are examined, it is understood that they tend to see Mathematics Teaching as "a teaching field with rules, stages and order". When the explanations of the "game" metaphors made by the candidate teachers were analyzed, it was seen that they pointed to two different themes. The metaphor "It is like a game; because it is learned by having fun" was coded under the theme of "A field that is fun and requires love" based on its explanation. The metaphor "It is like a game...because it has rules, and you continue to learn when you learn the rules" was included in the theme "A field of education with rules, stages and order" by considering the explanation. A similar situation is also valid for the "puzzle" metaphor. The themes were reached by taking into account the explanations made to the metaphor. Examples of the metaphors produced by candidate teachers for the concept of "Mathematics Teaching" are given below:

A Non-Ending Basic Useful Space: The candidate teachers who produced metaphors under this theme stated that they see mathematics teaching as a field of learning that is necessary for life.

Processes Metaphor: "In our lives, we constantly do things, we perform operations. Mathematics teaching is these operations, we add something to our lives, it is addition, we subtract something from our lives, it is subtraction. Mathematics teaching is the same way, we add new information to our knowledge, like addition. We use these throughout our lives."

A teaching field with rules, stages, and order

Puzzle Metaphor: "Mathematics is a step-by-step path and requires a mathematical foundation. If one piece is missing, we cannot reach the goal." (C31)

An Abstract-difficult, complex teaching field

The metaphor of Saving Money in the Bank: "It takes time, it takes effort, it is difficult, it is abstract, it requires patience, but in the end, the bank and its customers who deposit money in the bank benefit from this business." (C17)

A field that requires fun and love

Game Metaphor: "I think we should give the lessons to the students in the most entertaining and real-life related way. This opens the door to love". (C75)

Within the scope of the first question of the research, the metaphors of teachers' mathematics teaching were examined. The metaphors produced by teachers for the concept of "Mathematics Teaching" are presented in Table 5.

Table 5. Primary school teachers' Metaphors for the Concept of "Mathematics Teaching"

Theme	Metaphor (Frequency)	Frequency
A Non-Ending Basic Useful Space:	Puzzle(3), commander(1), learning life(1), logic prevails(1), life (5), birds chirping(1), problem solving in life(3), wheat(1), game(3), bees(1), guidance in life(1), water(1), lighthouse(1), blood circulating in our veins(1), never-ending legacy(1), success(4), salt(1), making numbers talk(1), rings formed by a stone thrown into water(1)	32
A Teaching field with a Rich Solution Path	Labyrinth(1), island of discovery(1), life(1), discovery(1), land(1)	5
A Teaching field with Rules, Stages, and Order	Jigsaw(1), chess(3), game(7), raising a baby(1), puzzle(9), lego(1), crossword(3), key(1), knotted pile of string(1), jigsaw(2), Rubik's cube(1), hoe(1), climbing a steep mountain(3), constructing a building (2), fictionalizing(1), constructing(1), machine(1), sprouting and growing a seed above the soil(1), building a wall(2), logic(1), matryoshkas(1), critical period(1), model making(1)	46
A Space Requiring Diversity in Teaching Methods and Techniques	Growing flowers(1), formalism(1), a choreographed dance(1), puzzle(1), theater play(1),	5
An Abstract-Difficult-Complex Teaching field	Making logic-numbers-abstraction tangible(1), hereafter(1), life(1), spider web(1), sculpture(1), acrobat(1), painting(1), air(1)	8
A Fun and Love Requiring Space	Riding a bike(3), puzzles(5), seeds(1), playing with numbers(1), amusement park(1), dark chocolate(1), magic lamp(1), dynamic learning(1), playing games(1), core (1)	16

As seen in Table 5, the metaphors produced by the teachers for the concept of "Mathematics Teaching" were explained in six (6) themes: "*A teaching field with rules, stages and order*", "*A basic-useful-endless tool*", "*A field that is fun and requires love*", "*An abstract-difficult-complex teaching field*", "*A teaching field with rich solutions*". Primary school teachers produced the most metaphors under the theme of "*A Teaching Field with Rules and Stages*" for the concept of Mathematics Teaching. This was followed by the metaphors related to the theme of "*A Basic Useful Teaching with No End*". According to these results, it can be said that candidate teachers tend to see Mathematics Teaching as "*A Useful Teaching field with Rules and Stages*". Examples of the metaphors produced by teachers for the concept of Mathematics Teaching are given below:

A Non-Ending Basic Useful Space:

Life Learning Metaphor: "A guide in life". (T5)

A Teaching field with a Rich Solution Path

The Island of Discovery Metaphor: "Treasure can be reached in every way. The map is a criterion, but short or winding roads also lead to the treasure." (T14)

A Teaching field with Rules, Stages, and Order

Puzzle Metaphor: "If we cannot place the pieces correctly, if we cannot teach the concepts, the puzzle can never be whole. It is always incomplete, always incomplete". (T12)

A Space Requiring Diversity in Teaching Methods and Techniques

The metaphor of formalism: "It is impossible to explain the subject without concretizing mathematics, without using materials, without creating a plate in the student's mind." (T21)

An Abstract-Difficult-Complex Teaching field

The metaphor of Making Logic-Numbers-Abstractness Palpable: "Although mathematics is a lesson that finds a place in daily life, it does not change the fact that it is a relatively abstract and difficult lesson." (T24)

A Fun and Love Requiring Space

Core Metaphor: "It is very enjoyable to teach. Once you start the lesson, you cannot stop". (T58)

Within the scope of the second question of the research, the metaphor themes produced for the concepts of teaching and mathematics teaching were examined. The metaphor themes produced for "Teaching" and "Teaching Mathematics" are presented in Table 6.

Table 6. Comparison of Themes Related to Candidate and Primary School Teachers' Metaphors of Teaching and Mathematics Teaching

Themes of Teaching Concept		Themes of Mathematics Teaching	
Primary School Teacher Candidate	Primary School Teachers	Primary School Teacher Candidate	Primary School Teachers
Developing, Useful, Infinite Knowledge Process (f=57)	Teacher Qualification (A Process Requiring Love, Effort, and Labor) (f=11)	A teaching field with no end of basic usefulness (f=29)	A Non-Ending Basic Useful Space (f=32)
Mutual Impact Process (f=4)	Mutual Impact Process (f=7)	A teaching field with rules, stages, and order (f=30)	A teaching field with rules, stages, and order (f=46)
Process of Discovering Talents - Individual Differences (f=4)	Process of Discovering Talents - Individual Differences (f=8)	An abstract-difficult, complex teaching field (f=14)	An abstract-difficult, complex teaching field (f=8)
Teacher Qualification (A Process Requiring Love, Effort, and Labor) (f=13)	An Emotionally Rich, Productive Action (f=8)	A field that is fun and requires love (f=8)	A Fun and Love Requiring Space (f=16)
	A Necessary-Cumulative Process (f=39)		A Teaching field with a Rich Solution Path (f=5)
	The Job of Providing Useful Information and Guidance to People (f=40)		A Space Requiring Diversity in Teaching Methods and Techniques (f=5)

When Table 6 is examined, it is understood that the metaphor themes of primary school teachers' both teaching and mathematics teaching are diversified compared to candidate primary school teachers. The fact that the metaphors produced by the teachers are related to more themes can be accepted as a sign that professional experience leads to a richness in the meanings attributed to these concepts.

DISCUSSION, CONCLUSION, AND SUGGESTIONS

It is a known fact that teacher beliefs have an undeniable place and importance in teaching. For this reason, in this study, the metaphors of candidate primary school teachers and primary school teachers about mathematics teaching and teaching were examined to determine the mental framework they formed about the subject.

Inferences from Pre-service Teachers' and Teachers' Metaphors Regarding the Concept of "Teaching"

The most prominent theme for candidate teachers' teaching metaphors was "*developing, useful, accumulative, infinite knowledge process*", while the themes of teachers were "*giving useful information to people, guiding, and a necessary-accumulative process*". It is understood that both candidate and teachers characterize the concept of teaching as a phenomenon that is beneficial to people and develops them. It can be said that the themes of "*Process that develops people-useful etc.*", "*Mutual impact process*", "*Process of discovering talents and individual differences*" and "*Teacher quality (a process that requires love, effort, and labor)*" correspond to the themes of "*Process of transferring knowledge*", "*Interaction*", "*Shaping*" and "*Effort*" that Çetinkaya and Eskici (2018) determined for the teaching metaphor of candidate teachers. These results are similar to the results of some other studies (Martinez et al., 2001).

Teaching and learning can also be characterized as a useful process of acquiring knowledge aimed at the development of the individual. It can be said that the education received by candidate and primary school teachers has led to the formation of this conceptual framework. It can be said that candidate teachers schematize teaching as a process of guiding individuals to acquire knowledge rather than transferring knowledge and that they adopt innovative learning approaches. A recent study focused on the relationship between mathematics teachers' talk about teaching and their teaching practices and found that the teaching practices of teachers with both traditional and innovative discourses were also related to their discourses (Davis, Towers, Chapman, Drefs, & Friesen, 2020). If these results are evaluated together with the results of our current study, it can be said that the beliefs of teacher candidates and teachers about the concept of teaching can be reflected in their teaching practices.

When the other themes related to the concept of teaching are examined, it is understood that both candidate and primary school teachers have a view on *individual differences and abilities* in teaching following their teaching content knowledge. This mental schema for the concept of teaching is in line with the explanations in the Primary School Mathematics Curriculum (MoNE, 2018). The only striking difference here is that teachers produced metaphors for the concept of teaching that fall under the theme of *a productive action that provides emotional richness*. It can be thought that teachers gain emotional richness in the teaching process with the effect of professional experience and reach the pleasure of teaching-learning. The fact that some of the teachers' teaching and mathematics teaching metaphors were collected in the affective attribution theme is consistent with the view that metaphors can reflect not only cognitive but also affective attributions towards events and phenomena (Kadunz & Straber, 2004; Eren & Tekinarslan, 2013). As a result, it can be stated that teachers and candidate teachers have a mental framework for teachers' teaching competencies, their mastery of a certain subject area, their competence in explaining this subject area, and their role in facilitating the process.

Inferences from Pre-service Teachers' and Teachers' Metaphors Regarding the Concept of "Mathematics Teaching"

In the metaphors related to *mathematics teaching*, the common themes of a teaching field with rules, stages, and order, a teaching field without a basic useful end, and a teaching field with rules, stages, and order come to the fore for both candidate primary school teachers and primary school teachers. These are followed by the themes of an abstract-difficult, complex teaching field; a field that requires fun and love. Unlike candidate teachers, primary school teachers also produced metaphors for mathematics teaching as a teaching field with rich solutions and a field that requires diversity in teaching methods and techniques.

It can be said that both candidate teachers' and teachers' metaphors of mathematics teaching in the theme of *an abstract-difficult teaching field* contain negativity about teaching and learning mathematics. In reality, teachers' mental schemas about mathematics teaching include *mathematical knowledge, beliefs about mathematics teaching and learning, and several other factors* (Ernest, 1994). Olsen (2020) reached similar results in a study. Beliefs about the nature of mathematics are also the primary source of teachers' beliefs about students' teaching and learning (Cross, 2009). The beliefs they formed in their undergraduate courses on teaching and learning may have been effective in their schematization of mathematics teaching as a rule-gradual and cumulative process. In this study, it can be stated that teachers' beliefs about mathematics teaching may have been influenced by their beliefs about the nature of mathematics and the accumulation of teaching strategies used in the lessons.

When the metaphors of candidate and teachers about the concept of mathematics teaching were examined, the themes of *"an abstract-difficult, complex and patience-requiring teaching field"* and *"a teaching field that has no basic useful end"* came to the fore the most. It can be said that the theme of *"necessity/indispensability"*, which Tarım et al. (2017) identified as one of the themes that candidate primary school teachers produced the most metaphors about mathematics teaching, corresponds to the theme of *"a basic useful teaching field that has no end"* in this research. Again, the theme of *"a field that is fun and requires love"* obtained in this study overlaps with the theme determined by Tarım et al. (2017) as *"desire/emotion"*. The fact that teachers produced fewer metaphors than candidate teachers on the theme of mathematics teaching as an *"an abstract-difficult-complex teaching field"* can be considered a result of their teaching experiences and that their perceptions started to turn positive. Sahin (2013)'s result that pre-service teachers who had difficulties in mathematics during their high school years perceived mathematics as a difficult lesson supports our findings. Primary school teacher candidates study mainly mathematics in high school. Therefore, their perceptions of mathematics are positive. The mathematics teaching metaphors of teachers and candidate teachers may have been influenced by their mental codes about the content of mathematics and mathematics teaching. Despite the teaching experience of teachers and candidate teachers who had difficulties in learning mathematics during their student years and saw mathematics as a difficult learning field, they may continue to see mathematics learning and teaching as a difficult field due to the stability in beliefs. This issue can be addressed in future research.

The fact that teachers produced metaphors about mathematics teaching under the themes of *"a teaching field with rich solutions"* and *"a field that requires diversity in teaching methods and techniques"* indicates that their exploration of mathematics teaching increased with experience. These two themes produced by primary school teachers differently from candidate teachers can be considered as a sign that beliefs about mathematics teaching have started to change with professional experience and professionalization in the profession. This result is in line with the views suggesting that implicit beliefs in learning and teaching conceptions may differ depending on whether one is a student or a teacher (Saban et al., 2007). Teachers have to show different teaching and solution methods while teaching mathematics to students in their classes. For this, the teaching methods and strategies used in the lessons have to be diversified. With these experiences, it can be thought that some of the teachers produced metaphors that fall under the themes emphasizing the activities of mathematics teaching.

Inferences from Metaphor Themes Regarding the Concepts of "Teaching" and "Mathematics Teaching"

It is understood that both teachers and candidate teachers have a mental schema about the concepts of teaching and mathematics teaching as a useful and endless knowledge-teaching process. Similarly, metaphors emphasizing affective qualities about both teaching and mathematics teaching were also used. It can be said that Shaw and Mahlios' (2008) conclusion that candidate primary school teachers' metaphors about teaching and literacy teaching indicate diversity in beliefs, but that these metaphors can be brought together in the context of dominant themes will also be valid for mathematics teaching and teaching metaphors, which is a special content area. Depending on experience, primary school teachers start to produce metaphors for affective and methodological knowledge. This result is proof of the change in beliefs with professional experience. It can be thought that candidate teachers' and teachers' implicit philosophies about mathematics are reflected in mathematics teaching. While mathematics teaching metaphors include mathematics subject area knowledge such as "*a field with rules, stages, and phases*" and teaching beliefs such as "*an abstract and complex field*", teaching metaphors also point to the subject area knowledge and beliefs about the teaching process. It can be said that the metaphor themes of teaching and mathematics teaching are differentiated at this point.

The environment of the university-level mathematics teaching course that candidate teachers underwent may have shaped their perceptions about mathematics instruction. It may be suggested that future research identify the metaphors employed by lecturers in mathematics teaching courses and analyze the interpretations that candidate teachers assign to these metaphors. It is also possible to look into how teachers' opinions about math instruction and learning affect students' attitudes toward math instruction and their performance in the mathematics teaching course. If teachers' classroom methods reflect their views on learning and teaching mathematics, this can be looked into. It may be suggested to investigate whether the schematization of mathematics teaching as a discovery process is due to beliefs about the nature of mathematics or beliefs about teaching strategy. It may be suggested that diversify the methods and strategies used in mathematics teaching courses. Exemplary applications for field teaching courses, such as mathematics teaching, may also be included in education science courses for teaching. Lessons in teacher training programs may be structured in an application-oriented manner.

Conflicts of Interest: The authors have no conflict of interest to disclose.

Funding Details: The authors declared that this study has received no financial support.

CRedit Author Statement: The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Ethical Statement: Approval for this study was obtained from the Sakarya University Social and Human Sciences Research Institute Ethics Committee. (07/07/2021-10)

REFERENCES

- Ball, D. L. (1990). Breaking with experience in learning to teach mathematics: The role of a preservice methods course. *For the learning of mathematics*, 10(2), 10-16. <https://eric.ed.gov/?id=ED318696>
- Bartelet, D., Vaessen, A., Blomert, L., & Ansari, D. (2014). What basic number processing measures in kindergarten explain unique variability in first-grade arithmetic proficiency? *Journal of Experimental Child Psychology*, 117, 12–28. <http://dx.doi.org/10.1016/j.jecp.2013.08.010>.

- Birks, D. F., & Malhotra, N. K. (2006). *Marketing Research: an applied approach*. Pearson Education UK.
- Bruning, R. H., Schraw, G. J., & Norby, M. M. (2014). Cognitive Psychology and Instruction (ZN Ersözlü ve R. Ülker, Trans.). Nobel Publishing. (Original work published 2010).
- Cochran, K. F., DeRuiter, J. A., & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of teacher Education*, 44(4), 263-272. <https://doi.org/10.1177/00224871930440040>
- Cross, D. I. (2009). Alignment, cohesion, and change: Examining mathematics teachers' belief structures and their influence on instructional practices. *Journal of Mathematics Teacher Education*, 12, 325-346. <https://doi.org/10.1007/s10857-009-9120-5>
- Çetinkaya, S., & Eskici, M. (2018). Teachers' Metaphorical Perceptions Towards Teaching. *Mediterranean Journal of Educational Research*, 24, 253-271. <https://doi.org/10.29329/mjer.2018.147.14>
- Davis, B. & R. Hersh (2002). The mathematical experience. (Abadoğlu, trans.). Doruk Publishing. (Original work published 1984).
- Davis, B., Towers, J., Chapman, O., Drefs, M., & Friesen, S. (2020). Exploring the relationship between mathematics teachers' implicit associations and their enacted practices. *Journal of Mathematics Teacher Education*, 23, 407-428. <https://doi.org/10.1007/s10857-019-09430-7>
- Desoete, A., Ceulemans, A., De Weerd, F., & Pieters, S. (2010). Can we predict mathematical learning disabilities from symbolic and non-symbolic comparison tasks in kindergarten? Findings from a longitudinal study. *British Journal of Educational Psychology*, 82, 64-81. <https://doi.org/10.1348/2044-8279.002002>
- Eren, A. & Tekinarslan, E. (2013). Metaphors regarding Teacher, Teaching, Learning, Instructional Material and Evaluation: A Structural Analysis. *Gaziantep University Journal of Social Sciences*, 12 (3), 443-467. Retrieved from <https://dergipark.org.tr/tr/pub/jss/issue/24232/256874>
- Ernest, P. (1994). 'The Impact of Beliefs on the Teaching of Mathematics', in Bloomfield, A. and Harries, T. Eds (1994) *Teaching and Learning Mathematics*, Derby: Association of Teachers of Mathematics.
- Godor, B. P. (2019). Gifted metaphors: Exploring the metaphors of teachers in gifted education and their impact on teaching the gifted. *Roeper Review*, 41(1), 51-60. <https://doi.org/10.1080/02783193.2018.1553219>
- Güner, N. (2013). Pre-service teachers' metaphors about mathematics. *Education Sciences*, 8(4), 428-440. Retrieved from <https://dergipark.org.tr/en/pub/nwsaedu/issue/19810/211892>
- Güres, F., & Bahsi, M. The investigation of mathematics field knowledge competences of the primary school teacher. *Journal of Anatolian Education Research*, 5, 1-12. Retrieved from <https://dergipark.org.tr/en/pub/jaer/issue/60689/853683>
- Güveli, E., İpek, A., Atasoy, E., & Güveli, H. (2011). metaphor perceptions of primary teachers towards the concept of mathematics. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, 2(2), 159-140. Retrieved from <https://dergipark.org.tr/en/pub/turkbilmat/issue/21564/231443>

- Harding, J. L., & Hbaci, I. (2015). Evaluating candidate teachers math teaching experience from different perspectives. *Universal Journal of Educational Research*, 3(6), 382-389. <https://files.eric.ed.gov/fulltext/EJ1066256.pdf>
- Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. *Second handbook of research on mathematics teaching and learning*, 1(1), 371-404. <https://books.google.com.tr/books?hl=tr&lr>
- Hirst, P. H. (1971). What is teaching?. *Journal of Curriculum Studies*, 3(1), 5-18.
- Işık, Ö. (2014). *Analysing the pre-service classroom teacher's perceptions through metaphors which are related to teacher, teaching and learning from the point of constructivism* (Unpublished Master's thesis), Pamukkale University.
- Joram, E., & Gabriele, A. J. (1998). Preservice teachers' prior beliefs: Transforming obstacles into opportunities. *Teaching and teacher education*, 14(2), 175-191. [https://doi.org/10.1016/S0742-051X\(97\)00035-8](https://doi.org/10.1016/S0742-051X(97)00035-8)
- Landerl, K., & Kölle, C. (2009). Typical and atypical development of basic numerical skills in elementary school. *Journal of experimental child psychology*, 103(4), 546-565. <https://doi.org/10.1016/j.jecp.2008.12.006>
- Kadunz, G., & Straber, R. (2004). Image--Metaphor--Diagram: Visualisation in Learning Mathematics. *International Group for the Psychology of Mathematics Education*.
- Kuzu, O., Kuzu, Y., & Sivacı, S. Y. (2018). Preservice Teachers' Attitudes and Metaphor Perceptions towards Mathematics. *Cukurova university journal of faculty of education*, 18(3), 1032-1052. 47(2), 897 – 931. Retrieved from <https://dergipark.org.tr/en/pub/cuefd/issue/40033/383527>
- Martínez, M. A., Sauleda, N., & Huber, G. L. (2001). Metaphors as blueprints of thinking about teaching and learning. *Teaching and teacher education*, 17(8), 965-977. [https://doi.org/10.1016/S0742-051X\(01\)00043-9](https://doi.org/10.1016/S0742-051X(01)00043-9)
- MoE (2018). İlkokul matematik dersi öğretim programı [*Primary School Mathematics Curriculum*]. Board of Education and Discipline. Ankara. <http://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMAT>
- Merriam, S. B., and Grenier, R. S. (2019). *Qualitative research in practice: Examples for discussion and analysis*. San Francisco, CA: Jossey-Bass Publishers.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. sage.
- Olsen, J., Lew, K., & Weber, K. (2020). Metaphors for learning and doing mathematics in advanced mathematics lectures. *Educational Studies in Mathematics*, 105, 1-17. <https://doi.org/10.1007/s10649-020-09968-x>
- O'Sullivan, M., MacPhail, A., & Tannehill, D. (2009). A career in teaching: Decisions of the heart rather than the head. *Irish Educational Studies*, 28(2), 177-191. <https://doi.org/10.1080/03323310902884227>
- Sadi, Ö. (2014). Students' conceptions of learning in genetics: A phenomenographic research. *Journal of Turkish Science Education*, 11(3), 53-63. <https://www.tused.org/index.php/tused/article/view/608/522>

- Sahin, B. (2013). Teacher candidates' metaphoric perceptions related with "mathematics teacher", "mathematics" and "math lesson" concepts. *Mersin University Journal of the Faculty of Education*, 9(1), 313-321. Retrieved from <https://dergipark.org.tr/en/pub/mersinefd/issue>
- Sener, Z. T., Bulut, A. S., & Ünal, H. (2017). The metaphorical perceptions of students on a teacher-training course towards the concepts of "teacher" and "teacher training". *Online Submission*, 3(7), 388-407. <https://files.eric.ed.gov/fulltext/ED575002.pdf>
- Pinar, B. A. L., Turan, A. K., & Kayıran, B. K. (2021). Analysis of elementary school teachers' evaluations regarding the mathematics curriculum. *Trakya Journal of Education*, 11(2), 717-731. <https://doi.org/10.24315/tred.696848>
- Ponte, J. P. D. (1994). Mathematics teachers' professional knowledge. In *International Conference for the Psychology of Mathematics Education (PME)* (pp. 195-210). <https://www.proquest.com/openview/3>
- Rose, P., Beeby, J. & Parker, D. (1995). Academic rigour in the lived experience of researchers using phenomenological methods in nursing. *Journal of Advanced Nursing*. 21(6), 1123-1129. <https://doi.org/10.1046/j.1365-2648.1995.21061123.x>
- Saban, A., Kocbeker, B. N., & Saban, A. (2007). Candidate teachers' conceptions of teaching and learning revealed through metaphor analysis. *Learning and instruction*, 17(2), 123-139. <https://doi.org/10.1016/j.learninstruc.2007.01.003>
- Schunk, D. H. (2009). Learning theories an educational perspective. (M. Şahin, *Trans. Ed.*). *Nobel publishing*. (Original work published 2008).
- Shaw, D. M., & Mahlios, M. (2008). Candidate teachers' metaphors of teaching and literacy. *Reading psychology*, 29(1), 31-60. <https://doi.org/10.1080/13540600701837632>
- Siegler, R. S., & Robinson, M. (1982). The development of numerical understandings. In *Advances in child development and behavior*. 16, 241-312). [https://doi.org/10.1016/S0065-2407\(08\)60072-5](https://doi.org/10.1016/S0065-2407(08)60072-5)
- Rittle-Johnson, B., & Star, J. R. (2009). Compared with what? The effects of different comparisons on conceptual knowledge and procedural flexibility for equation solving. *Journal of Educational Psychology*, 101(3), 529. <https://psycnet.apa.org/doi/10.1037/a0014224>
- Tarım, K., Özsezer, M. S. B., & Canbazoğlu, H. B. (2017). Primary Teachers' Perceptions on Mathematics and Mathematics Teaching. *Aii Evran University Journal of Kırsehir Education Faculty*. 18(3), 1032-1052. Retrieved from <https://dergipark.org.tr/en/pub/kefad/issue/59420/853436>
- Ural, O., Aydemir, İ., Toker-gokce, A. & Öztoprak-kavak, Z. (2016). Metaphorical perceptions of secondary school students and teachers about learning and teaching concepts. *Journal of Teacher Education and Educators*, 5(2), 131-153. Retrieved from <https://dergipark.org.tr/en/pub/jtee/issue/43266/525582>
- Vanbinst, K., Ghesquière, P., & De Smedt, B. (2015). Does numerical processing uniquely predict first graders' future development of single-digit arithmetic? *Learning and Individual Differences*, 37, 153-160. <https://doi.org/10.1016/j.lindif.2014.12.004>
- Vanbinst, K., Ceulemans, E., Peters, L., Ghesquière, P., & De Smedt, B. (2018). Developmental trajectories of children's symbolic numerical magnitude processing skills and associated cognitive competencies. *Journal of Experimental Child Psychology*, 166, 232-250. <https://doi.org/10.1016/j.jecp.2017.08.008>

- Walshaw, M., & Anthony, G. (2007). The role of pedagogy in classroom discourse. *Mathematics: Essential research, essential practice*, 765-774. <https://citeseerx.ist.psu.edu/document?repid>
- Wegner, E., Burkhart, C., Weinhuber, M., & Nückles, M. (2020). What metaphors of learning can (and cannot) tell us about students' learning. *Learning and Individual Differences*, 80, 101884. <https://doi.org/10.1016/j.lindif.2020.101884>
- Wilcox, S. K., Schram, P., Lappan, G., & Lanier, P. (1991). The role of a learning community in changing preservice teachers' knowledge and beliefs about mathematics education. *For the Learning of Mathematics*, 11(3), 31-39. <https://www.jstor.org/stable/40248031>
- YOK (2019). Classroom teaching undergraduate programs. https://www.yok.gov.tr/Documents/Kurumsal/egitim_ogretim_dairesi