



A Problem Solving Course Case: Examination of Preservice Mathematics Teachers' Perceptions

Ayşe Tuğba Öner^a



^a*İstanbul Medeniyet Üniversitesi, Eğitim Bilimleri Fakültesi, Matematik ve Fen Bilimleri Eğitimi Bölümü, İstanbul, Türkiye*

Abstract

Addressing all students' needs is important for effective teaching. In teacher education programs, it is vital to introduce reform-based instructional approaches to preservice teachers (PST) while emphasizing the essence of subject matter knowledge, pedagogical content knowledge and knowledge about diverse students. This study represents preservice mathematics teachers' perceptions about distinctively designed Mathematical Problem Solving course. The design of the course basically had an emphasis on problem solving, diversity, and equity consciousness and framed by a hypothetical learning trajectory. The data were gathered through semi-structured interviews. PSTs' responses were analyzed by thematic analysis. PSTs' perceptions about the Problem Solving in Mathematics course were grouped under four themes and these were efficacy, awareness, shortcomings, and problem sets as challengers. In general PSTs pointed that the course was effective on improving their previous content knowledge and belief about being a better mathematics teacher, learning heuristics in problem solving, and creating an awareness on diversity and equity while it had some shortcomings such as time management or lack of guidance needed by PSTs. Problem sets were one of the main components of the problem solving and posing structure of the course and these problems were non-routine problems which many PSTs found it difficult as well.

ARTICLE TYPE

Research

ARTICLE HISTORY

Received 24 August 2019

Accepted 31 December 2019

KEY WORDS

Problem solving, preservice mathematics teachers, diversity, equity

Atıf bilgisi: Öner, A. T. (2019). A problem solving course case: examination of preservice mathematics teachers' perceptions. *Harran Maarif Dergisi*, 4 (2), 74-92. doi: 10.22596/2019.0402.74.92

Sorumlu yazar: Ayşe Tuğba Öner, **e-posta:** atugbaoner@gmail.com

*Data used in this paper was obtained from the project, named as Knowledge for Algebra Teaching for Equity (KATE), that is funded by the National Science Foundation, grant # 1020132. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author and do not necessarily reflect the views of the National Science Foundation.

Introduction

To have effective teaching and learning in a classroom environment, prospective teachers' must be educated in a way that they can meet the needs of all students. In teacher education programs, prospective teachers should be introduced to reform-based instructional approaches to address deficiencies in students' mathematics knowledge (Ponte & Chapman, 2008) and knowledge about diverse students (Sleeter, 2001). In diverse middle grade classrooms, to address the need of all students preservice teachers (PSTs) should not only be equipped with the pedagogical content knowledge (Shulman, 1986, 1987) but also be equipped with equity consciousness (McKenzie & Skrla, 2011). Demographic information of prospective teachers listed as usually female, white and middle class (Sleeter, 2001) and these teachers differ from the lowest performing students group who are different from them in terms of racial, ethnic, income or cultural aspect. Therefore, it is vital to educate PSTs and enhance their knowledge about multicultural classroom settings in order them to manage teaching and learning environment (Ladson-Billings, 2011).

Building diversity awareness is especially challenging with the typical pre-service elementary/middle grades teacher population (Brown, Davis, & Kulm, 2011) and few teacher education programs prepared PSTs to teach and meet the needs of diverse population (Watson, Charner-Laird, Kirkpatrick, Szczesiul, & Gordon, 2006). Therefore not only courses focused on diversity and equity offered in teacher education programs, but also other courses focused on concentration areas should be intertwined with diversity and equity awareness if PSTs' consciousness about these issues is wanted to be developed. Integrating instruction in problem solving and activities to promote PSTs to think about teaching for diversity was effective in enhancing beliefs about teaching for equity (Brown et al., 2011). This paper presents the results of a Mathematical Problem-Solving course, which is an required course for bachelor of science degree program in interdisciplinary studies with a certification in Middle Grades 4-8 Math/Science, having a specific design (i.e. HLT) differed from commonly known problem solving course from PSTs' point of view.

Theoretical Framework

The theoretical framework addresses the design of the approach enhancing PSTs' development of knowledge for teaching problem solving while also expanding their beliefs and understanding of equity and diversity. The framework for this work was a hypothetical learning trajectory (HLT), which guided the design and instruction of the Mathematical Problem Solving course that served as the treatment of the study.

Hypothetical Learning Trajectory

Not only to enhance preservice mathematics teachers' content knowledge and problem solving and posing skills but also their beliefs about and abilities to teaching diverse students, the Knowledge for Algebra Teaching for Equity (KATE) research project team constructed a HLT, which followed the model of Simon & Tzur (2004), as the theoretical framework for the Mathematical Problem Solving course. The model was supposed to meet following assumptions: a) understanding the existing knowledge of the students, b) using the HLT as a tool for learning mathematical concepts, c) assuming mathematical tasks as vehicle to promote learning and a key part of the instructional process, and d) due to having an hypothetical nature, the teacher modifies every aspects of HLT (Simon & Tzur, 2004, p. 93). During the construction of the HLT, the model developed by Lamberg and Middleton (2009) was used and this model included "a) a description of the conceptual scheme, (b) cause and effect mechanisms that describe the teachers' knowledge, (c) cognitive interpretations of teachers' knowledge, and (d) intermediary understandings necessary for bridging to the next level" (p. 237). Two HLTs were used; the first HLT for solving algebra problems and the second for teaching algebra for equity. First HLT included four conceptual scheme: 1) direct translation, 2) textbook four-step, 3) generalized pattern, and 4) heuristic. The second HLT consisted of three conceptual scheme: 1) situated learning, 2) culturally relevant context, and 3) critical pedagogy (Brown et al., 2011). These research-based schemes describe strategies that can be used by teachers to engage and motivate diverse middle grade students while they enjoy and learn how to solve algebra problems. More detailed explanations of each scheme were given in the following.

Direct translation. Verbal or non-routine problems were expected to translate from words

into expressions or equations meaning that using particular words for specific algebraic operations.

Textbook four-step. These steps were similar to Polya's (2004) four step approach however were stated more simpler. Reading problem, identifying data, identifying unknowns and writing equation could be listed as textbook four step (Brown et al., 2011).

Generalized pattern. This conceptual scheme consisted of generating numbers and generalizing patterns in the given problems.

Heuristic. PSTs were directed to use four steps suggested by Polya (2004) and solve given problems while explaining all steps in details.

Situated learning scheme. In this learning scheme, students are expected to learn mathematics by concrete and hands-on activities with real-world problems that could be solved using mathematical skills, concepts, and tools (Brown et al., 2011). Students' mathematics understanding depends on their cultural experiences (Ladson-Billings, 1994) and is built from concrete to abstract.

Culturally relevant teaching scheme. In this scheme, including cultural contexts into math problem solving activities is essential. Relating mathematics teaching to students' cultures and lives would be motivational (Ladson-Billings, 1998) and can support students' understanding because these types of problems provide examples of the relevance of math in daily life (Brown et al., 2011).

Critical pedagogy scheme. This scheme provides students with insights into mathematics that is related to everyday socio-political realities. Activities are presented in the context of social problems and injustices, enabling students to identify problems, find plausible solutions, and react to social injustices (Brown et al., 2011). Problems with social contexts can be adapted and formed in ways that are interesting to diverse students (Brown et al., 2011; MacLaughlin, Shepard, & O'Day, 1995).

The purpose of this qualitative study is to understand preservice mathematics teachers' opinions about problem solving course intertwined diversity and equity. The research question of the present study was: What is preservice mathematics teachers' perception about problem solving course intertwined equity and diversity?

Methods

In this section, information about the participants, procedures, and data sources employed to address the research question were presented.

Participants

Twenty-five middle grades mathematics PSTs enrolled in a required Problem Solving in Mathematics course at a large Southwestern Research I university. There were 21 females, 20 White, three Hispanic and two Asian PSTs. Eight out of 25 PSTs were willing to interview. The participants of this study were one White male, one Hispanic male, one Hispanic Female and five White females. All participants' identifier information was removed and new ID numbers were assigned to them.

Procedures

In the Problem Solving in Mathematics course that served as the implementation of this study, PSTs were provided with guidance about how to solve mathematics problems by using four principles to solve a problem suggested by Polya (2004), how to incorporate their pedagogical knowledge to content knowledge, and how to address diverse students' needs. The course materials were not only designed to improve PSTs' pedagogical content knowledge and algebra content knowledge but also to emphasize diversity and equity awareness.

The Problem Solving in Mathematics course included four primary, interrelated components: 1) Math Problem Solving and Problem Posing, 2) Math Problem Equity Challenges, 3) Readings and Discussions on Diversity, and 4) Second Life (SL) Tutoring and Teaching.

Math problem solving and problem posing. PSTs were asked to read the book "How to Solve It" (Polya, 2004) and use it as a textbook to solve given non-routine algebra problems. These problems were called as "problem sets" and PSTs had to complete four steps properly to solve problems and submit in their solutions as an assignment. PSTs were also asked to prepare a teaching plan and pose problems to middle grade students for a mock teaching that was at the end of the semester.

Math equity problem challenges. During the problem solving course, three distinctive assignments were given to PSTs. These assignment was called as Equity Problem

Challenges and consisted of four components: a problem having one of the HLT scheme to solve and adapt for middle grade students, responding to student misconceptions, planning a problem solving lesson, and addressing possible mathematics and equity questions asked by middle graders.

Readings and discussions on diversity. Readings from the textbook, *Responding to Diversity* (Ellis, 2008), were given to PSTs as well as other essays on teaching for diversity. In addition to readings and discussion about essays, two guest lecturers whose study emphases were on diversity and equity were invited; they discussed cultural diversity and cognitive engagement during the their presentation.

Second life tutoring and teaching. PSTs were introduced to Second Life, a 3D virtual world, that had a virtual middle school classroom and additional learning spaces named as KATE. The KATE classroom was designed for PSTs to tutor and teach middle grade student avatars who were acted intentionally by graduate students. PSTs started to learn how to use their own avatars and then were asked to tutor and assist a middle grade student who had an algebraic misconception in the middle of the term. At the end of the term PSTs were asked to teach an algebraic concept to a group of middle graders in the virtual classroom.

Data Sources

The data set were obtained by interviews having a semi structured design that included some questions directed to participants in order to understand their perceptions about the problem solving course. “What was your experience in the course this semester?”, “What are your thoughts about the course curriculum and the problem solving?” and “What would have improved the class?” were examples of some interview questions. Before analyzing the data, all taped interviews were transcribed and ATLAS.ti software was used for coding. To obtain overall feeling besides attending the course whole semester, all written transcripts were read several times. To analyze the data set, thematic analysis as a qualitative analytic method was used. Thematic analysis was defined as “method for identifying, analyzing, and reporting patterns (themes) within data” (Braun & Clarke, 2006, p. 79). To complete thematic analysis, six phases were suggested to use: “1) familiarizing yourself with your data, 2) generating initial codes, 3) searching for themes,

4) reviewing themes, 5) defining and naming themes, and 6) producing the report” (Braun & Clarke, 2006, p. 87). The flexibility and its usefulness to provide a rich and detailed account of data (Braun & Clarke, 2006, p. 78) were the main reasons why thematic analysis was chosen.

The implementation of the study –Problem Solving in Mathematics course – took one semester. The author of the study engaged with participants during the semester and that was the longest time, which the researcher can spend for the present study. One of the validity lenses proposed by Creswell (2016) was participant and in the participant lens prolonged engagement in the field was one validity strategy, which helps to build researcher to make more accurate and salient decisions (Creswell, 2007). Another important strategy was to provide detailed and thick description of the field, where it was explained in the procedures part of this paper in detail.

Results

PSTs’ perceptions about the Problem Solving in Mathematics course were grouped under four themes and these were efficacy, awareness, shortcomings, and problem sets as challengers.

Efficacy

PSTs mentioned about the efficacy of the course in several ways. They indicated that the course helped them to refresh their previous knowledge and improved their content knowledge. For instance PST20 and PST03 indicated following statements, respectively; “Oh, gosh, it (course) made me use so many things I hadn't thought of in years. Like the simplest algebra that everyone should know, but it definitely brought back some old knowledge.” and “I think the problems we were exposed to were of such a wide variety that just kinda expands our horizons in algebra.”

PSTs felt that the course was effective to improve their pedagogical content knowledge and belief being a better mathematics teacher, learn different conceptual schemes for teaching for diversity, understand and apply problem solving steps suggested by Polya (2004). PST06’s following statement showed the efficacy of the course in terms of teaching for diversity “I think this class helped out, knowing that there were a lot of difference, and different problems affect different students, and the questions that we had

on the dinner problem and soda cane problem.” In addition to that, PST19’s following statement “I think it (course) makes it better to understand why students have misconceptions and made it easier for me to be able to sit down and understand those misconceptions and go around them and teach them in a different way.” showed that the course was also efficient to have PSTs understand middle grade students’ mathematical misconceptions.

According to PSTs, not only this problem solving course but also other courses given in the undergraduate program were also effective for teaching for diversity. The design of the course was planned to have PSTs work on teams and individual so this characteristic of the course was also mentioned by PSTs and listed as an efficacy of the course.

Awareness

Interviews revealed that the course emerged and increased PSTs awareness about content knowledge, pedagogical content knowledge, diversity, middle grade students’ misconceptions, and the importance of teaching experience. The course made some PSTs to realize the importance of knowing subject matter knowledge for teaching. As an example PST03 stated “it made me feel like: how am I gonna teach math if I don’t know how to do it myself?”. Insufficient content knowledge was one the salient category that PSTs realized after taking the course and PST06 pinpointed this by “I definitely need to review all math. You think you know stuff, and then like one of the students asked what a proportion was, and it took me a second to even come up with a definition for it. So I definitely need to go back and look at a lot of things.”

PST06 and PST12 mentioned how the course helped them to be aware of diverse mathematics classroom and following statements were example of their perspectives about this category, respectively: “you don’t realize that teachers use your name, and you don’t realize that in a problem. Like they do that for a reason, I guess. And so I never realized that until I got in this class.” and “it (course) has helped me come up with different types of questions to ask and to be a little more knowledgeable about diversity in my classroom.”

Shortcomings

During interviews PSTs pointed out some issues that they encountered during the

semester. Disorganized classroom settings, time management problems, and similarities of each assignment about non-routine problems could be listed as shortcomings of the course. As an example PST18 mentioned about the time management issue in a way that a thing she/he would change about the course: “Probably spend(ing) more time going over the problems and stuff, like 'cause I know we would start going over them in class and sometimes we would run out of time, so maybe just better time management on that part.”

Additionally the lack of connection between theory and practice, connection among concepts being taught, and guidance during some exercises were also mentioned by participants. PSTs felt that there was a limited explanation given to them about the course materials; as an example PST23 stated “We were told things, and I don’t feel like it was really shown how it was gonna connect later on...” PST18 expressed the need for assistance about course materials while questioning her/himself as well: “I do wish we had someone who kind of I guess helped us a little, maybe, like told us probably on the – and maybe that was partially my fault. I should have probably gone to office hours more or something and said what are the misconceptions you think you're gonna be had in this problem, or something like that. 'Cause I really had no idea.”

Problem Sets as Challengers

Problems sets were used as material for one of the component- math problem solving and problem posing- for this course. Because PSTs heavily focused on different non-routine problems almost each week until midterm, it was not surprising to find categories about problem sets in the data. Problem posing, heuristic approach for problem solving, non-routine problems in the problem sets, quality of problem sets, significance of prerequisite knowledge to solve problems, PSTs lack of self-confidence to solve problems, displeasure of focusing on non-routine problems, and finding problems as difficult and challenging were emphasized.

PST06 emphasized the difficulty of posing a logical and relevant problem: “How hard it is to come up with a problem was actually kind of challenging. Like the test we just took, it took me a little bit to come up with a lot of them. Especially when you already have an equation that you're going based off of.” PST18 also pointed out same issue by saying: “how to formulate questions like questions that your students are gonna want to be interested in solving, 'cause that part was kind of difficult too, and that part was really good

when we were trying to come up with our own problems, because we thought it wouldn't be that tough at first, but then we realized how it's kind of challenging problems that make sense but are also kind of interesting and that the students would problem enjoy a little bit.”

PST19 stated “I liked the Polya steps. It's a very analytic way to just lay it out and how to teach students, I guess” to mention about heuristic method and its effect on learning how to solve a problem; however, they also found problems challenging as well. As an example, and PST12 and PST22 stated following statements to express problems' difficulties, respectively: “I'm pretty good at the fundamentals. It's when we get into problems that are a little bit trickier that I'm like, "Ooh, I kind of messed up on that, I think." Like I'm not really 100 percent sure. I'm not 100 percent confident in myself, I guess.” and “The most challenging part for me was the problem sets that we did at the very beginning of the class, 'cause I hadn't taken a math class in years. So it was a lot of practice.”.

Discussion

There were studies in the literature investigating teachers' beliefs about mathematics courses in general. Some studies focused on mathematics method course that is a crucial course in mathematics teacher education programs (Hart, 2002; Quinn, 1997; Wilkins & Brand, 2004) as well as problem solving courses (Emenaker, 1996; Schoenfeld, 1998). In this section, study results in the literature were discussed in terms of similarities and differences in this study.

Studies showed that mathematics methods course had positive effect on preservice teachers' content knowledge, attitude, beliefs, and self-efficacy (Hart, 2002; Quinn, 1997; Wilkins & Brand, 2004). Quinn (1997) reported that the use of manipulatives, technology, problem solving and cooperative learning in mathematics method course statistically significantly changed preservice elementary teachers' (PET) attitudes toward mathematics and meaningful knowledge of mathematical content whereas there was no statistically significant change in secondary mathematics teachers' attitudes and content knowledge. Another study also revealed similar results; taking mathematics methods course changed preservice elementary school teachers' beliefs consisted with mathematics reform of that time and self-efficacy in a positive direction (Wilkins & Brand, 2004).

The present study showed parallelism with Quinn's (1997) study in terms of PSTs' perceptions about improvement on their mathematics content knowledge. As a result, it would not be unfair to say any kind of well-structured mathematics course would be expected to increase participants' mathematics knowledge. However the present study also differ in terms of not being a mathematics methods course. Problem solving course in general focuses on improving problem solving skills and creating awareness on how to solve and pose problems in order to form meaningful mathematics teaching and learning.

To help students be problem solvers, teachers need to be problem solvers as well so from this point of view Emenaker (1996) examined the impact of problem solving based course on teachers' mathematical beliefs. Emenaker's (1996) problem solving course was a typical problem solving course in teacher education programs which was focused on using problem solving approach to improve preservice teachers' conceptual understanding of mathematics while working in groups. At the end of the course PSTs' beliefs about following positions were positively changed: a) having many ways to solve problems, b) not relying on memorized step-by-step procedures, c) memorization does not play large role in mathematics, and d) understanding concept is more powerful than memorization. Several ways to solve a problem, memorization versus understanding, personal confidence and average people, changes in teaching, and influential aspects of T104 were five themes emerged from the interviews performed with PSTs in Emenaker's (1996) study. Two of these themes were parallel with the present study results. In Emenaker's study, PSTs believed that problem based mathematics course changed their ideas about how to teach mathematics and their confidence in problem solving abilities were improved. PSTs believed that they would be more empathetic to the difficulties their students encounter and they focused on understanding material instead of memorization of the rules. From this point of view PSTs in the present study also pointed out the importance of their meaningful understanding of mathematics to be able to teach it, which showed similarity with Emenaker's findings.

In Schoenfeld's (1998) problem solving course, where he emphasized mathematical community and the importance of thinking mathematically (i.e. using multiple approaches, generalizations, justifications), students found problems difficult and frustrating at first like what PSTs noted in this study as well. One of the themes of the present study was problem sets as challengers and one category was about how PSTs found problem sets challenging

and difficult to solve. When students encounter with a problem that have not been seen before or if they have not solved a similar one, it could be difficult and frustrating at first; but later when they found or were given a hint to solve, it would be no longer challenging for them (if the problem is solvable). This was also the case for the mathematical problem solving presented in this study.

The Problem Solving in Mathematics course in this study differed from other problem solving courses because it also structured and designed to emphasize diversity and equity consciousness to encourage PSTs to feel more comfortable teaching all students. Many aspects of other problem solving courses (i.e. heuristics, mathematical exploration, justification etc.) used in the present study however this study was enriched with three conceptual schemes (i.e. situated learning, critical pedagogy, and culturally relevant teaching), responding to student misconceptions, planning a problem solving lesson, and addressing possible mathematics and equity questions. Surrounding the course with equity and diversity awareness was one of the distinctive and crucial differentiations of this study from others.

Conclusion

In this study, the aim was to examine preservice mathematics teachers' perceptions about the Problem Solving in Mathematics course, which was intertwined diversity and equity awareness. Therefore data obtained from eight PSTs were examined qualitatively. Four themes emerged from data and these were efficacy of the course, awareness, shortcomings of the course, and problem sets as challengers. Theoretical framework of this study introduced the special design of the course, which was structured by two HLTs and consisted of following conceptual schemes for algebra problem solving and teaching algebra for equity: 1) direct translation, 2) textbook four-step, 3) generalized pattern, 4) heuristic, 5) situated learning, 2) culturally relevant context, and 3) critical pedagogy. The main difference of this problem solving course was actually its surrounding by HLT for teaching algebra for equity. Therefore, in the problem solving course during semester readings about equity and diversity and problems including HLT themes were emphasized as well as problem solving heuristics. As a result of this course, PSTs found the course efficient in terms of refreshing their previous knowledge, improving their content and

pedagogical content knowledge, being a better mathematics teacher, understanding students' misconceptions. In addition, PSTs also mentioned about shortcomings of the course such as disorganized classroom settings, time management problems, and similarities of each assignment about non-routine problems, the lack of connection between theory and practice, the lack of connection among concepts being taught, and the lack of guidance during some exercises. Likewise problem sets were one of the main components of the course and PSTs found it challenging however using heuristic approach for problem solving quality of problem sets were also positive opinions of students about the course. I believe the salient theme was awareness even though positive changes in the PSTs awareness was one of the main purpose of the course, it was very influential to find that PSTs realized many concepts even if they know yet fully understand. When PSTs were encountered situations such as tutoring or teaching diverse middle graders, they realized the importance of content, pedagogical content knowledge, and teaching experience.

Consequently, introducing teacher education program courses intertwined equity and diversity consciousness is very crucial because major area courses are important to improve PSTs' subject matter knowledge and pedagogical content knowledge but not sufficient to train them to teach all students. Therefore intertwining major area courses with diversity and equity could help PSTs' perceptions and beliefs about being able to teach all students and being a better educator.

References

- Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Brown, I. A., Davis, T. J., & Kulm, G. (2011). Pre-service teachers' knowledge for teaching algebra for equity in the middle grades: A preliminary report. *The Journal of Negro Education*, 80(3), 266-283.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.

- Creswell, J. W. (2016). *30 Essential skills for the qualitative researcher*. Thousand Oaks, CA: Sage.
- Ellis, M. W. (Ed.) (2008). *Mathematics for every student: Responding to diversity, grades 6-8*. Reston, VA: National Council of Teachers of Mathematics.
- Emenaker, C. (1996). A problem-solving based mathematics course and elementary teachers' beliefs. *School Science and Mathematics, 96*(2), 75-84.
- Hart, L. C. (2002). Preservice teachers' beliefs and practice after participating in and integrated content/ methods course. *School Science and Mathematics, 102*(1), 4-14.
- Ladson-Billings, G. (1994). *The Dreamkeepers: Successful teachers for African American children*. San Francisco: Jossey Bass.
- Ladson-Billings, G. (1998). Just what is critical race theory and what's it doing in a nice field like education? *International Journal of Qualitative Studies in Education, 11*(1), 7-24.
- Ladson-Billings, G. (2011). Is meeting the diverse needs of all students possible? *Kappa Delta Pi Record, 48*(1), 13-15.
- Lamberg, T., & Middleton, J. A. (2009). Design research perspectives on transitioning from individual microgenetic interviews to a whole-class teaching experiment. *Educational Researcher 38*(4), 233-245.
- MacLaughlin, M. W., Shepard, L. A., & O'Day, J. A. (1995). Improving education through standards-based reform: A report by the National Academy of Education Panel in Standards-Based Reform. Stanford, CA: National Academy of Education.
- McKenzie, K. B., & Skrla, L. (2011). *Using equity audits in the classroom to reach and teach all students*. Thousand Oaks, CA: Corwin Press.
- Polya, G. (2004). *How to solve it: A new aspect of mathematical method*. Princeton University Press: Princeton, NJ.
- Ponte, J. P., & Chapman, O. (2008). Prospective mathematics teachers' knowledge and development. In L. English (Ed.), *Handbook of international research in mathematics education* (2nd ed., pp. 225-263). New York: Routledge.
- Quinn, R. (1997). Effects of mathematics methods courses on the mathematical attitudes and content knowledge of preservice teachers. *The Journal of Educational Research, 91*(2), 108-113.
- Schoenfeld, A. J. (1998). Reflections on a course in mathematical problem solving. In A. H. Schoenfeld, J. Kaput, & E. Dubinsky (Eds.), *CBMS issues in Mathematics Education* (Vol.7, pp. 81-113). Rhode Island: American Mathematical Society.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1-22.
- Simon, M. A., & Tzur, R. (2004). Explicating the role of mathematical tasks in conceptual learning: An elaboration of the hypothetical learning trajectory. *Mathematical Thinking & Learning*, 6(2), 91-104.
- Sleeter, C. E. (2001). Preparing teachers for culturally diverse schools: Research and the overwhelming presence of Whiteness. *Journal of Teacher Education*, 52(2), 94-106.
- Watson, D., Charner-Laird, M., Kirkpatrick, C., Szczesiul, S., & Gordon, P. (2006). Effective teaching/effective urban teaching: Grappling with definitions, grappling with difference. *Journal of Teacher Education*, 57, 395-409.
- Wilkins, J. L. M. & Brand, B. R. (2004). Change in preservice teachers' beliefs: An evaluation of a mathematics methods course. *School Science and Mathematics*, 104(5), 226-232.

Bir Problem Çözme Dersi Vakası: Matematik Öğretmen Adaylarının Düşüncelerinin İncelenmesi

Anahtar Kelimeler: problem çözme, matematik öğretmen adayları, çeşitlilik, eşitlik

Giriş

Sınıf ortamında etkili bir öğretim ve öğrenme için öğretmen adaylarının tüm öğrencilerin ihtiyaçlarını karşılayacak şekilde eğitilmesi gerekir. Çeşitliliğin olduğu ortaokul sınıflarında, bütün öğrencilerin ihtiyacını gidermek için, öğretmen adayları (PST) sadece pedagojik içerik bilgisi (Shulman, 1986, 1987) ile değil aynı zamanda eşitlik bilinci (McKenzie ve Skrla 2011) ile donatılmış olmalıdırlar. Genelde öğretmen adaylarının demografik bilgileri kadın, beyaz ve orta sınıf olarak listelenmektedir (Sleeter, 2001) ve bu öğretmenler, ırk, etnik, gelir veya kültürel açıdan kendilerinden farklı olan ve düşük performans gösteren öğrenci grubundan farklıdır. Bu nedenle, öğretmen adaylarının öğrenme ve öğretim ortamını yönetebilmeleri için onları çok kültürlü sınıf ortamları hakkında eğitmek ve bilgilerini artırmak önemlidir (Ladson-Billings, 2011). Bu çalışma Hipotetik Öğrenme Yolu (HÖY) adı verilen özel bir tasarıma sahip, 4-8. sınıf Matematik ve Fen öğretmenlerini yetiştiren lisans programının zorunlu bir dersi olan matematikte problem çözme dersini öğretmen adaylarının bakış açısından incelemektedir.

Teorik Çerçeve

Bu çalışmanın teorik çerçevesini HÖY oluşturmaktadır ki bu problem çözme dersinin dizaynını ve öğretimini yönlendirmiş ve bu çalışmanın uygulaması olarak yer almıştır.

Hipotetik Öğrenme Yolu

Cebir problemlerini çözme ve eşitlik için cebir öğretimi olmak üzere iki HÖY kullanılmıştır. İlk HÖY dört kavramsal şemadan oluşmaktadır: 1) direk çeviri, 2) ders kitaplarında kullanılan dört adım, 3) genelleştirilmiş örüntü ve 4) sezgisel. İkinci HÖY üç kavramsal şemadan oluşmaktadır: 1) yerleşik öğrenme, 2) kültürel olarak ilişkili kavram ve

3) kritik pedagoji (Brown vd., 2011). Bu arařtırmaya dayalı řemalar, çeřitlilięin olduęu orta okulda olan öęrenciler cebir problemlerinin nasıl çözüleceęini öęrenir ve eęlenirken öęretmenler tarafından öęrencileri motive etmek ve ilgisini çekmek için kullanabilecekleri stratejileri tanımlamaktadır.

Bu nitel çalıřmanın amacı matematik öęretmen adaylarının çeřitlilik ve eřitlik konularıyla bezenmiř problem çözme dersi hakkındaki görüşlerini anlamaktır. Çalıřmanın arařtırma sorusu řudur: Matematik öęretmen adaylarının çeřitlilik ve eřitlik konularıyla bezenmiř problem çözme dersi hakkındaki görüşlerini nelerdir?

Yöntem

Katılımcılar

Amerika Birleřik Devletlerinde güney batıda yer alan bir arařtırma üniversitesinde zorunlu bir ders olan Matematikte Problem Çözme dersine 25 ortaokul matematik öęretmen adayı katılmıştır. Katılımcıların demografik bilgileri 21 kadın, 20 Beyaz, üç Latin kökenli ve iki Asyalı olarak tanımlanmaktadır. 25 katılımcıdan sekizi görüşmeye katılmayı gönüllü olarak kabul etmiştir. Bu çalıřmanın katılımcıları bir Beyaz erkek, bir Latin kökenli erkek, bir Latin kökenli kadın ve beř Beyaz kadından oluşmaktadır.

Süreç

Matematikte Problem Çözme dersi dört birbiriyle iliřkili parçadan oluşmaktadır: 1) matematiksel problem çözme ve kurma, 2) eřitlik temasına dayalı matematiksel meydan okuma problemleri, 3) çeřitlilik konusunda okuma ve tartıřmalar, 4) Second Life'da gerçekteřen özel ders ve öęretim.

Veri Kaynakları

Katılımcıların problem çözme dersi hakkındaki görüşlerini elde etmek amacıyla yarı yapılandırılmış görüşme formu kullanılmıştır. Veri setini analiz etmek için nitel analitik yöntemlerden biri olan tematik analiz kullanılmıştır. Tematik analiz “veri içine yer alan örüntüleri (temaları) belirleme, analiz etme ve raporlama için kullanılan bir yöntem” (Braun ve Clarke, 2006, s.79) olarak tanımlanmıştır.

Sonuçlar

Matematikte Problem Çözme dersi hakkında öğretmen adaylarının algıları dört tema altında toplanmıştır ve bu temalar fayda, farkındalık, eksiklikler ve meydan okuyucu olarak problem setleri olarak adlandırılmıştır.

Fayda

Öğretmen adayları dersin faydasından farkı şekillerde bahsetmiştir. Katılımcılar dersin önceki bilgilerini tazelediği ve içerik bilgilerini geliştirdiğini belirtmişlerdir. Ayrıca öğretmen adayları dersin onların pedagojik içerik bilgilerini ve daha iyi bir matematik öğretmeni olduklarına karşı inançlarını artırmada, çeşitlilik için kullanılan farklı kavramsal şemaları öğrenmede, Polya (2004) tarafından önerilen problem çözme basamaklarını uygulama ve anlamada etkili olduğunu belirtmişlerdir. Ayrıca katılımcılar dersin ortaokul öğrencilerinin matematiksel kavram yanılgılarını anlamada faydalı olduğunu söylemişlerdir.

Farkındalık

Görüşmeler, dersin öğretmen adaylarının içerik bilgileri, pedagojik içerik bilgileri, çeşitlilik, ortaokul öğrencilerinin kavram yanılgıları ve öğretim deneyiminin önemi hakkındaki farkındalıklarını oluşturduğunu ve artırdığını ortaya çıkarmıştır. Ders bazı öğretmen adaylarının öğretim için konu alan bilgisinin önemini fark etmelerini sağlamıştır.

Eksiklikler

Görüşmeler esnasında öğretmen adayları dönem boyunca ders esnasında karşılaştıkları bazı konulara değinmişlerdir. Düzenlenmemiş sınıf ortamı, zamanlama problemleri ve rutin olmayan problemler hakkında verilen ödevlerin benzerlikleri dersin eksiklikleri olarak bahsedilmiştir. Ek olarak teori ve uygulama arasındaki bağlantının, öğretilen kavramlar arasında bağlantının ve bazı ödevlerdeki rehberliğin eksikliği katılımcılar tarafından vurgulanmıştır. Ders materyalleri hakkında kısıtlı açıklama verildiği ayrıca belirtilmiştir.

Meydan Okuyucu Olarak Problem Setleri

Problem setleri bu dersin yapılarından-matematik problem çözme ve problem

kurma- birisi olarak kullanılmıştır. Öğretmen adayları vize haftasına kadar her hafta rutin olmayan problemlerle ilgili çalıştıkları için verilerde problem setleri hakkında kategori bulunması sürpriz değildir. Problem kurma, problem çözme için sezgisel yaklaşım, problem setlerindeki rutin olmayan problemler, problem setlerinin kaliteleri, problemleri çözmek için önceki bilgileri kullanımının önemi, problem çözümede özgüven eksikliği, rutin olmayan problemlere odaklanmanın hoşnutsuzluğu ve problem setlerini zor ya da meydan okuyucu olarak bulunması vurgulanan bazı noktalardır. Ayrıca mantıklı ve ilişkili problem kurmanın zorluğu da bahsedilmiştir.