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Experimental Study on Mathematical Problem Solving Approach with Pre-service Elementary Teachers

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Abstract

The main purpose of this study is to investigate the effects of problem solving approaches on pre-service elementary teachers' basic mathematics achievement and problem-solving performance. The study has been conducted as quasi - experimental design with 110 elementary school pre-service teachers at a public University in Central Anatolia Region. The study has lasted 12 weeks. Experimental group has been instructed by questioning problem solving approach while control group has been instructed by traditional problem solving approach. The data have been collected through Basic Mathematics Achievement Test, Mathematical Problem Solving Test and has been analyzed by using multivariate analysis of covariance. The results have revealed that questioning problem solving approach has a statistically significant effect on pre-service elementary school teachers' basic mathematics achievement and problem solving performance (The effect size has been found as η2=0.265).

Key Words: *Mathematics education, questioning problem solving, basic mathematics achievement, problem-solving performance.*

Sınıf Öğretmeni Adaylarıyla Matematiksel Problem Çözme Üzerine Deneysel Bir Çalışma

Özet

Bu çalışmanın amacı, problem çözme yaklaşımlarının sınıf öğretmeni adaylarının, temel matematik başarılarına ve problem çözme performanslarına etkisini araştırmaktır. Çalışma, yarı deneysel çalışma olarak İç Anadolu Bölgesindeki bir devlet üniversitesinde 110 sınıf öğretmeni adayı ile gerçekleştirilmiştir. Deneysel çalışma 10 hafta sürmüştür. Deney grubuna sorgulayıcı problem çözme yaklaşımı ile ders işlenirken, kontrol grubunda geleneksel problem çözme yaklaşımı ile ders işlenmiştir. Veriler, Temel Matematik Başarı Testi ve Matematiksel Problem Çözme Testi ile toplanmıştır. Elde edilen veriler çok yönlü kovaryans analizi kullanılarak analiz edilmiştir. Sonuçlar, sorgulayıcı problem çözme yaklaşımının öğretmen adaylarının temel matematik başarılarına ve problem çözme performanslarına anlamlı bir etkisi olduğunu göstermiştir (Etki büyüklüğü η2=0.265 olarak bulunmuştur).

Anahtar Sözcükler: *Matematik eğitimi, sorgulayıcı problem çözme, temel matematik başarısı, problem çözme performansı.*

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Introduction

Mathematics is an important part of life affecting family and social life. Individuals come across with mathematical problems in their daily lives as consumers, citizens, and workers (Rey et al., 2007). Results of many studies indicate that in this digital world we live in, advanced mathematical and technical skills required in many professions (Xin et al., 2005).

Ministry of Education (MoNE, 2005a) reported that students' mathematical success is a necessary tool for national economy and social life. Information society of this century necessitates individuals to have "new proficiencies" beyond their basic skills, and these new proficiencies have been subject to various different studies in literature (Altun & Sezgin–Memnun, 2008, MoNE, 2005a; Schoenfeld, 1985). One of these is problem solving. In order to succeed and to develop, our nation needs individuals who can solve various problems, who can think rationally, and who can make effective decisions when necessary. Mathematics education aims to train individuals who are not only able to know mathematics but who are also able to apply their knowledge and solve problems (Umay, 2007).

Problem solving is also a scientific method. It requires including critical, creative, and reflective thinking abilities as well as analytical and synthetical skills into the aims of all courses (Posamentier & Krulick, 1998). Thus, mathematics teachers are all in agreement that problem solving skills is of utmost importance and improving students' problem solving skills should be their top priority in teaching.

Most mathematical concepts and methods, if not all, are best thought of through problem solving (van De Walle, 2005). Problem solving is defined as a search for an appropriate action path which is not immediately achievable in order to get to an aim (Polya, 1973) by effort and advanced thinking (Krulik and Rudnick, 1989). For problem solving process knowing the definition of a term problem is crucial. By looking at different sources (Altun, 2008; Krulik & Rudnick, 1989; Polya, 1962; Schoenfeld, 1985; Umay, 2007), it can be stated that a problem is "a situation in which a solution is not apparent", "requires thoughts and synthesis previously learned in order to resolve it", "a difficulty for the person who faces it", "a situation that the individual needs to solve", "an individual that has not faced the problem situation before and he or she is not prepared to solve it". From all of these definitions it seems clear that mere recalls of facts or applications of previously learned algorithm do not lead to a solution and a case which is modeled once or a case which is easily solvable by applying previously learned algorithms are not considered problems anymore. All the questions used in the present study had the main characteristics of the problem defined previously.

When literature was taken into consideration, it was seen that studies concerning problem solving are mostly based on Polya's framework (e.g., Koç, 1998; Özkaya, 2002; Özalkan, 2010). However, there are other frameworks by other researchers as well (Artzt & Armour-Thomas, 1992; Sarver, 2006; Carlson & Bloom, 2005). While Polya (1973) developed a model that focuses on four stages as understanding the problem, devising a plan, carrying out the plan, and looking back, Schoenfeld (1985) described mathematical problem solving revised from Polya's framework with five episodes: reading and analyzing, exploration, planning/ implementation and verification. Garofalo and Lester (1985)'s problem solving framework consisted of four stages as orientation, organization, execution and verification. In literature, in national and international publications, no matter what the problem solving framework was, there were studies that explore the applicability of different problem solving methods on participants and its impact on certain variables (attitude, achievement, problem solving performance) (e.g.,Cai, 1994; Pugalee, 2001; Harskamp & Suhne, 2007; Özalkan, 2010; Yıldız, 2008). For instance Tanrıseven (2000) found that there was a significant difference between traditional problem solving and problem solving with dramatization. Posluoğlu (2002) showed collaborative learning technique improved 5th grade students' problem solving skills. In another study, Follmer (2000) reported that the teaching on non-routine problems

in the fourth grade has improved the use of cognitive strategies and the awareness of how to solve the problem. While the control group of the present study Polya's four–phased model was utilized, its experimental group was instructed with questioning problem solving method. In this instruction Polya's problem solving framework were integrated with the questioning and discourse because questioning is an important part of learning and determine the quality of teaching (Carlsen, 1993; as cited in Roth,1996). Moreover, it can help students to focus on the context, to be aware of their learning difficulties ,to review the subject, to improve their thought (Borich, 1988; as cited in Ekweme & Okpobiri, 2012); to give emphasis on a procedure; to clarify their views, to monitor the discourse in the class and their own thinking (van Zee & Minstrell, 1997; vab Zee, Iwasyk, Kurose, Simpson, & Wild, 2001); to motivate them to focus on new knowledge (Omar, 2009); to promote their high order thinking (Gallas, 1995). Classroom discourse was also integrated because of used in the experimental design because classroom discourse provided students' mathematical thinking (Kazemi, 1998) specifically teacher questioning, affected students' cognitive domain (Chin 2006). In addition, mathematical classroom discourse lead students to make reasoning (White, 2003). It could be stated that most of the studies in literature conducted to investigate the effects of different problem solving approach on elementary, middle or high school students (e.g., Higgins, 1997; Arslan, 2003;Yavuz, 2006; Cai, 2003). But there were few studies based on pre-service teachers (e.g., Altun & Sezgin-Memmun, 2008; Brown, 2003). The present study was carried out with elementary pre- service teachers because the quality of mathematics education, which affects the quality of work produced by students, is up to the quality of teachers (Ball 1989; 2000). It is thought that this study can guide pre-service teachers throughout the application of questioning problem solving process in class.

As a result in the present study the following research question has been investigated:

What are the effects of questioning problem solving approach compared to traditional problem solving approach on pre-service elementary school teachers' mathematics achievement and problem-solving performance when their pre-test basic mathematics achievement and problem-solving performance test scores are controlled?

Method

Research Design

This study was a quasi-experimental study since not the individuals but the groups were randomly assigned to experimental and control groups (Fraenkel & Wallen, 1996). The matching-only pretest-posttest control group design was used (Fraenkel & Wallen, 1996). In experimental group questioning problem solving approach was instructed while in control group traditional problem solving approach was used. Basic Mathematics Achievement Test and Mathematical Problem Solving Test were given to both control and experimental groups before and after the treatment as pre-tests and post-tests.

Participants

The participants of the study consisted of 110 first grade pre-service elementary teachers of a public university in Central Anatolia Region during the spring semester in the 2007-2008 academic year. The groups were assigned randomly as experimental and control groups. A total of 57 students were involved in the control group and 53 students were involved in the experimental group.

Instruments

Basic Mathematics Achievement Test (BMAT)

This test was developed by the researchers to determine basic mathematics achievement of freshman pre-service teachers. All of the questions in the test were related to the subject-matter of the course entitled Basic Mathematics II. The test consisted of 12 open-ended questions. Some items of the test (4 items) were developed by a researcher and other were adapted from several references (e.g., MoNE (2005a), Olkun (2006) and Secondary Education Entrance Examination (OKS) question).

They were based on course curricula approved by Institute of Higher Education (e.g. definition

of an equation in algebra, equations on unknown first and second degrees, relation and function concepts and samples). The table of specifications was formed by using Bloom's Taxonomy. The test combined typical mathematical achievement questions and piloted with third grade pre-service elementary teachers in the same department of same University

In obtaining evidence on the face and content validity of this instrument, nine mathematics educators were involved. Before the implementation, they judged whether the items were appropriate for grade level and measurement. Appropriateness of the 12 questions in the measurement tool was examined by the experts, and was graded out of 7 points. In the Table 1 below was given the validity point average for each question.

Table 1. Validity scores mean of BMAT's questions

Question #	1	2	3	4	5	6	7	8	9	10	11	12
Validity score mean	6.71	6.85	7	7	7	7	6.85	6.85	7	7	7	6.85

As seen from the table, validity scores mean was range between 6.71 and 7.0, so none of the questions was taken out from the test. Only Turkish expressions in some questions were corrected.

To grade each question, the five point rubric was used developed by researchers. General criteria were presented in Table 2.

Table 2. Rubric description for BMAT

Description	Scores
Completely in correct or no responses.	0
Solution was begun but not completed or solution was incomprehensible.	1
There was a solution but important points related to the solution were skipped or calculation errors were made.	2
There was a solution but it was not clear, calculations and representations were not very clear.	3
Almost a complete solution	4
Completely correct solution	5

The minimum and maximum possible scores from the test items are 0 and 60 points.

The value of Cronbach alpha from the post implementation of the BMAT was 0.76. Since the test was open- ended, this value was in the accepted interval (Nitko, 2001). This test was used for both pretest and posttest in the present study.

Internal consistency reliability coefficient was calculated as 0.93.An expert in the field was involved in the study for this procedure.

Mathematical Problem Solving Test (MPST)

This test consisted of problems related to topics of the Basic Mathematics II course. It had 17 open-ended questions. The aim of the test was to determine problem solving performances of pre-service teachers. Before preparing the final form of the test, a problem pool was formed by the researchers with respect to the first grade pre-service teachers' mathematical knowledge, backgrounds and reasoning and their cognitive level. Problems were selected to cover every concept of the Basic Mathematics Course II, (e.g., definition of an equation in algebra, equations on unknown first and second degrees, relation and function).

Most of problems were adapted from a variety of mathematics books and literature (e.g., MONE (2005a), Olkun (2006) and OKS)

and four of were developed by researchers. In the selection of questions to be included in the test, such criteria as the originality of questions, questions' consisting at least 2 different solution strategies were taken into consideration. (e.g., working backwards, finding a pattern, adopting a different point of view).

For face and content validity nine experts in the field were involved. They judged whether the problems were appropriate, for grade level and measurement. They solved the problems and checked whether they were solvable by at least two different solution strategies or not. The test received its final form, with respect to those nine experts. Table 3 was illustrated the validity score mean for each problem.

Table 3. Validity scores mean of MPST's problems

Problem #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Validity score mean	7	7	7	7	7	7	6.66	6.66	7	6.66	6	6.33	6.33	6.33	6.66	7	7

No problem was taken out of the designed test after consulting with the experts because of experts' validity scores was calculated between 6.33 and 7. Only formal and contextual formats of questions and the way they are expressed were revised and corrected.

To score the students' responses to each problem a MPST, five-point holistic grading rubric developed by Umay (2007) was used. Thus, a numerical score was assigned to whole solution process of each problem in the test. Some criteria in general were listed as follows in Table 4.

Table 4. Holistic Rubric for evaluate problem solving performance developed by Umay (2007)

Description	Scores
• Completely blank • Only data were written down, no attempt for solution • Wrong answer and indicators of a inappropriate reasoning were seen.	0
• Indicators of a correct strategy was written but no application. • Not reached the aim, some unclear mathematical work, but no put-forth result. • Correct answer but inappropriate reasoning	1
• Correct strategy was found, but the student was not able to apply it or he/she has not tried hard enough. • Correct answer was found, but there was no indicator as to how it was achieved.	2
• Correct strategy was found and applied, but there was no correct answer due to some calculation errors and misconceptions. • Correct strategy was found and correct answer was present but some errors during the application were seen.	3
• Correct strategy was found and applied correctly, but because one or several of data were misevaluated, correct answer was not reached.	4
• Complete and appropriate solution and correct answer	5

The minimum and maximum possible scores from the test items were 0 and 85 points, respectively.

The value of Cronbach alpha from the post implementation of the MPST was measured at 0.70. This value was also accepted value because it consisted of open-ended questions (Nitko, 2001). To measure internal consistency reliability, an expert in the field was involved in the study. After completion of the post test, the researcher and an expert graded the scores correlation coefficient was calculated between the researcher scores and expert's scores 0.92.

Treatment

The study was conducted in Basic Mathematics II course, applied in Elementary Teacher education division throughout the semester. The Basic Mathematics II course was offered as a compulsory course to elementary teacher education students in the first year of the curricula of the program. The course length was 2 hours per week throughout the semester. The main difference between the two groups was the implementation of the problem solving. The content was not changed for the groups. Same mathematical problems were solved in both groups. Both groups were instructed by the researcher as a regular teacher. Throughout the study, both the experimental and control groups were observed for treatment verification and researcher bias. They were given the observation checklists to determine the degree to which the instructor implemented the treatment in experimental and control group. This checklist included 32 items about classroom, environment, student reactions and teacher behavior during instructions to compare classroom conditions for each group. The researcher calculated the correlations between ratings of each observer for observation checklist items for experimental group as 0.88. The correlation coefficients were calculated by Pearson correlation. Similarly, correlation coefficient between two observers for the CG was found 0.92. These rating coefficients between two observers are high and significant. In addition, Mann Whitney U was used whether the observed mean differences between groups were statistically significant or not. According to the results it can be said that treatment verification was supported.

Treatment in Experimental Group

In this present study, questioning problem-solving was applied to give students the opportunities to consistently engage in problem solving, discuss their solution strategies and build on their own informal strategies.

A sample problem solving process was presented below by a problem related with a "function and relation" concept. The problem was prepared in line with the objective "investigating if a given relation is a function or not and being able to apply the definition of function".

> *"Problem: The decision taken by a university management about offering new courses is as follows: If the number of students is less than 10 the course will not be offered; if it is between 10-20 only one section will be offered; if it is between 21-40 two sections will be offered; if it is between 41-60 three sections will be offered". According to this, is the relation between the number of students and the number of groups a function? Explain with reasons* (Olkun, 2006.)

The class started with the distribution of the work sheets on which this problem is written. The problem was read loudly and the students were given 7-10 minutes to solve the problem by themselves. Within this time interval, the teacher walked around the classroom, providing explanatory information about the problem. For validation of Polya's problem solving model, teacher asked questions such as "Are there any points in the problem that are not clear?", "Did everyone understand the problem?", "What is the unknown?, What are the data? ". If it was needed the teacher provided explanatory information about the problem and gave advice as: "If you cannot solve the proposed problem try to restart to solve the problem". The aim for asking these questions was developing pre- service teacher's behaviors for understanding the problem and making the plan.

After this phase, the students, if they still needed, could benefit from their classmates, the teacher or the clue cards. The researcher prepared clue cards before the lesson on which some hints were written as short

reminders. For instance *"the conditions for a relation to be a function"* was written on the clue cards as short reminders for this problem. This process lasted between 5-7 minutes. They could talk, walk in the classroom and discuss with other students if they wanted to. While the students were working on the problem, the teacher moved around the classroom to observe their work, gave some clues, made suggestions or gave individual help to students who had difficulty approaching the problem. The teacher asked their students to find an alternative or second solution strategy if they found one and to check their solution and should ask certain questions such as: "*Can you check the result, "Can you check the argument?", "Are you sure?, "Can you defend your solution?"*.

The idea here is to help students express themselves by encouraging them to talk and write about the processes they use to solve problems. The teacher carefully called on students, asking them to present their solution method on the board. The order of selecting students was important for both encouraging those students who used naive methods and highlighting the student's ideas in relation to the mathematical connection among the methods that would be discussed. In this phase, by asking questions and making suggestions teacher tried to develop skills about Polya's third and fourth phases: carry out the plan and check the result.

At the end of this process, discussion was started by the teacher. Students who solved the problem by using different strategies and different computation method were asked to come to the board and encouraged to show and explain their work. Every different solution could be discussed and students would easily see the other student's different strategies and compared several solutions with the same correct answer. Presenting an idea, even a wrong one, was strongly encouraged and praised. The teacher was not to generate solutions but rather to help the students make the best of the resources they had. The teacher asked the classroom questions like: *"Does anyone have any suggestions?", "Any others?", "What made you think of that?", "What makes you think it's a better alternative?"*. Finally, after discussion if no student used a specific anticipated method, the teacher might proceed with only those that were not brought up. The errors, questions or unclear parts were taken into account by the teacher to make it easy for students' inference. The teacher reviewed and summed up the lesson and if necessary, and if time allowed, posed an exercise or an extension task that applies to what the students just learned from the lesson. This implication of the treatment was lasted 10 weeks.

Treatment in Control Group

In control group the majority of the classroom environment developed around the teacher. Problem solving approach was based on Polya's problem solving model but differed from experimental implementation according to poverty of interrogation. It might be defined as traditional problem solving. Same problems were solved as in experimental group. Rarely, the volunteer students solved the problems on the blackboard, asked questions and participated in lessons. Sometimes students tried to solve the problems but mostly the teacher solved it by her solution strategy. Thus, students neither discussed different solutions nor live the questioning problem solving. The teacher provided an explanation to the solutions. The teacher's responsibility was to offer students clear explanations and instructional objectives within a classroom. Teacher asked questions and made suggestions and guided for validation of Polya's problem solving model.

Findings

The null hypothesis related to research question of this study tested by MANCOVA is as follows:

H 1: There is no significant overall effect of different problem solving approaches on the collective dependent variables of the pre-service elementary school teachers' post test scores on basic achievement test and problem-solving performance test when participants' pre-test scores on basic achievement test and problem-solving performance test are controlled.

The results of this MANCOVA Model are illustrated in Table 4.

Table 4. Multivariate tests results for the MANCOVA comparing PostBMAT and PostMPST

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
Intercept	0.485	55.767	2.000	105.000	0.000	0.515	1.000
PreBMAT	0.855	8.918	2.000	105.000	0.000	0.145	0.969
PreMPST	0.872	7.712	2.000	105.000	0.001	0.128	0.944
Group	0.735	18.931	2.000	105.000	0.000	0.265	1.000

As it is seen from Table 4, it was found that there was a statistically significant overall effect of different problem solving approach on the collective dependent variables of the PostBMAT and PostMPST when the PreBMAT and PreMPST were controlled [F(2, 105) =18.931, Wilks' λ=0.735, p=0.000].

The eta square was found as 0.265, so the effect size was large according to the guidelines proposed by Cohen and Cohen (1983). This inferred as 26.5% of the total variance of model for the collective dependent variables of the PostBMAT and PostMPST was explained by the treatment. Observed power of the study was 1.000. This was higher than the calculated power of the study, which was 0.80.

Analyses of covariances (ANCOVA) were conducted as a follow-up analysis to evaluate the mean difference between the groups with respect to each dependent variable. In ANCOVA the hypothesis-wise alpha level was divided by 2 which was the number of dependent variables (Green & Salkind, 2004). Table 5 presents the results of the ANCOVA.

Table 5. Follow- up Pairwise Comparison for comparing PostBMAT and PostMPST

Dependent Variable	Groups	Mean	SD	F	Sig.	df	Partial η^2	Observed Power
PostBMAT	EG	37.37	8.84	6.250	0.014*	1,106	0.056	0.698
	CG	34.16	9.11					
PostMPST	EG	51.71	11.73	34.681	0.000*	1,106	0.247	1.000
	CG	36.82	11.10					

p*<0.025

From the Table 5, a statistically significant mean difference was seen for the PostBMAT between groups in the favor of questioning problem solving approach [F(1,106) =6.25, p=0.014<0.025, η^2=0.056; $M_{EGPostBMAT}$=37.37,$SD_{EGPostBMAT}$=8.84; $M_{CGPostBMAT}$=34.16, $SD_{CGPostBMAT}$=9.11].

The eta squared for the posttest scores of the BMAT was approximately 0.06 and this value was equal to small effect size (Cohen & Cohen, 1983). This indicated that approximately 6% of multivariate variance of the PostBMAT was associated with the group factor.

Additionally, it can be seen from Table 5, there was a statistically significant mean difference for the PostMPST between groups in the favor of questioning problem solving approach [F(1,106)=34.68, p=0.000<0.025, η^2=0.24; $M_{EGPostMPST}$=51.71, $SD_{EGPostMPST}$=11.73; $M_{CGPostMPST}$=36.82, $SD_{CGPostMPST}$=11.10]. The eta square was found as 0.247 for PostMPST. This was large effect size (Cohen and Cohen,

1983). It indicated that approximately 25% of multivariate variance of the PostMPST was associated with the group factor. The most increase in mean scores with respect to the both BMAT and MPST was observed in the experimental group. In other words, pre-service teachers in the experimental groups had higher gain scores than the control group's participants with regard to the BMAT and MPST.

Discussion and Recommendations

It was observed that both groups BMAT and MPST scores increased at the end of the treatment, but according to results, the experimental group was more successful than the control group in problem solving and achievement tests. Additionally, findings revealed that approximately 27% of the total variance for the collective dependent variables of the PostBMAT and PostMPST was explained by treatment. Therefore, the results of this study were of practical significance. Because of limitation the results of the study were limited to the population with similar characteristics, thus the results were only representative of that group.

The results of this study provided an evidence for conducting similar studies with different samples and topics.

In both groups, by different problem solving approaches pre-service teachers' problem solving skills were developed. Thus, the reasons were supported by the literature which were stated that there was an attempt to learn and to develop problem solving skills at different grade levels (eg; Koç,(1998), Çalışkan (2007), Verschaffel et al. (1999), Nancarrow (2004), De Corte (2004), Higgins (1997), Verschaffel & Corte (1997),Verschaffel et al. (1999), Follmer (2000)). But it can be said questioning problem solving approach was more effective on pre- service teachers' problem solving skills. The reason could be that it enabled pre-service teachers to work over problems cognitively and metacognitively in deep. By teacher guidance they might learn to read and understand the problem, to find the suitable solution strategy and to find an alternative one. Besides this by whole class discussions students could see the other student's different strategies and compare several solutions with the same correct answer. Thus this provided pre- service students' repertoire of solution strategies so this may affected problem solving skills positively.

The other finding was found that there was a statistically significant mean difference between groups in terms of mathematics achievement score in the favor of questioning problem solving approach. At the end of the study both groups achievement score were increased, but in experimental group more improvement was observed. Thus, it can be inferred that questioning approach was more effective than the problem solving approach applied in control group. This reason might be explained that by questioning approach pre-service teachers might learn to think deeply and widely, consider alternative solutions and check the results in a given mathematical situation.

Özsoy (2005) and Karaoğlan (2009) found that there was a significant and positive relation between mathematical achievement and problem solving skills. Likewise their findings it may said that when pre-service teachers in both groups became successful problem solvers, they became high mathematics achievers. Thus the development of problem solving may affect the general achievement in mathematics (Özsoy, 2005). In addition, as mentioned in the literature (Altun &Sezgin Memnun 2008; Özsoy, 2007) problem solving might contribute positively to pre-service teachers' in both groups cognitive development. This cognitive development may affect their problem solving skills and mathematics achievement positively.

When the findings obtained in this study are taken into consideration, it is possible to make some suggestions for pre-service teachers, mathematics teachers and experts in the field. Present study has supported that in mathematics course questioning problem solving improves mathematics achievement and problem solving skills more than the other approach. So investigating the effect of questioning problem solving with different group sizes, and at different grade levels in other mathematics courses has been suggested. Additionally, elementary pre-service teacher education students need to be prepared to teach mathematics

utilizing problem solving as a pedagogical methodology. In elementary pre-service teacher education program there are two courses named Mathematics Teaching I and II courses. Thus, problem solving course should be needed, when considering the objectives of Mathematics Teaching I and II courses.

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Uzun Özet

Bu çalışmanın amacı, problem çözme yaklaşımlarının sınıf öğretmeni adaylarının, temel matematik başarılarına ve problem çözme performanslarına etkisini araştırmaktır. Çalışma, yarı deneysel çalışma olarak İç Anadolu Bölgesindeki bir devlet üniversitesinde 110 sınıf öğretmeni adayı ile gerçekleştirilmiştir ve 12 hafta sürmüştür. Çalışmada deneysel yöntem olarak kullanılan problem çözme yaklaşımı, Polya'nın dört aşamalı modeli ile sorgulamaya dayalı öğretim modeline entegre edilerek yürütülmüş, öğretmen adaylarının ihtiyaç duydukları süreçlerde arkadaşlarından, öğretmenlerinden ve önceden hazırlanmış ipucu kartlarından yardım almalarına olanak sağlayacak şekilde tasarlanmıştır Süreç boyunca derslerde çözülen problemler öğretmen adaylarının akıl yürütmelerini ve üst düzey düşünme becerilerinin ortaya koyabilecekleri şekilde belirlenmiştir. Öğretmen adaylarının süreç içinde bilişsel ve üst biliş stratejilerinin kullanmalarına olanak sağladığı, kendi problem çözme stratejilerinin geliştirmelerine, onların süreç içinde sorgulayarak öğrenmelerine olağan kıldığı için bu problem çözme yaklaşımı sorgulayıcı problem çözme olarak tanımlanmıştır. Kontrol grubunda yine Polya'nın problem çözme basamaklarını temel alan, ancak biraz daha geleneksel olarak tanımlanabilecek bir problem çözme yaklaşımı uygulanmıştır. Öğretmen adaylarının daha çok bireysel çalıştıkları, süreçte yardıma ihtiyaç duyduklarında deney grubundaki gibi arkadaşlarından veya ipucu kartlarından yardım almadıkları, öğretmen öğrenci işbirliği ile yürütülen bir süreçtir.

Veriler, Temel Matematik Başarı Testi ve Matematiksel Problem Çözme Testi ile toplanmıştır. Elde edilen veriler çok yönlü kovaryans analizi (MANCOVA) kullanılarak analiz edilmiştir. Sonuçlar, sorgulayıcı problem çözme yaklaşımının öğretmen adaylarının temel matematik başarılarına ve problem çözme performanslarına anlamlı bir etkisi olduğunu göstermiştir. Araştırmanın bulguları değerlendirildiğinde öğretmenler, öğretmen adayları ve öğretmen yetiştiren kurumlar için önerilerde bulunulabilinir.

Matematik sınıflarında büyük ölçüde problem çözmede geleneksel yaklaşım benimsenmektedir. Fakat hem bu çalışma sonuçları hem de alan yazındaki çalışmalar geleneksel yaklaşımın öğrencilerin hem kavramsam öğrenmelerini hem de üst düzey düşünme becerileri çok da fazla geliştirmediğini göstermiştir. Sorgulayıcı problem çözme olarak adlandırılan problem çözme yaklaşımının geleneksel yaklaşıma kıyasla, öğretmen adaylarının matematik başarılarını ve problem çözme becerilerini geliştirdiği dikkate alınmalıdır.