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Improving Primary School Prospective Teachers' Understanding of the Mathematics Modeling Process

Ayten Pınar BAL[a]
Çukurova University

Ahmet DOĞANAY[b]
Çukurova University

Abstract

The development of mathematical thinking plays an important role on the solution of problems faced in daily life. Determining the relevant variables and necessary procedural steps in order to solve problems constitutes the essence of mathematical thinking. Mathematical modeling provides an opportunity for explaining thoughts in real life by making connections with knowledge and skills. Research concerning mathematics education indicates that there are several problems faced when trying to apply modeling to problem solving. This research has been done using the action research model in order to help primary school prospective teachers understand the process of mathematics modeling. Participants in the study consisted of 36 freshmen in total who were continuing their education in the department of primary school teaching of a state university during the 2011-2012 academic year. For selecting participants, the criteria sampling method, a purposeful sampling method, was used. The tools for data collection were comprehension and operational tests which related to mathematical modeling as well as weekly evaluation tests created within the framework of the action plans prepared by the researchers (variables test I-II, model formation test and model analysis). At the beginning of the research, it was observed that teacher candidates were not able to create modeling activities related to mathematics problems. As a result of the action plans, it was observed that as the success of a teacher candidate's ability to perceive a problem increased, their operational success also increased and they were able to create modeling activities for the given problems.

Keywords

Action Research, Math, Mathematical Modeling, Primary School Prospective Teachers, Problem Solving.

In recent years, one of the most debated subjects in the field of mathematics education is the concept of mathematical modeling that covers the transfer of mathematics into daily life (Blum & Ferri, 2009). In general, a model is a simplified form of a complex object or process, and modeling is a complex process that includes activities created in many stages (Maull & Berry, 2001). Sriraman (2005) also indicates that modeling is a process that is used when there is a problem, and a model is the product obtained at the end of the modeling process (Güneş, Gülçiçek, & Bağcı, 2004). The purpose of modeling is to interpret, configure and try different possibilities for achieving a result, as well as to facilitate the understanding of deeper events (Budinsk, 2010).

The concept of modeling is useful in mathematics education, particularly within the context of the

a **Ayten Pınar BAL, Ph.D.**, is an assistant professor of Elementary School Teaching. *Correspondence:* Çukurova University, Faculty of Education, Department of Elementary School Teaching, Sub-department of Primary School Teaching, Adana, Turkey. Email: apinar@cu.edu.tr

b Ahmet DOĞANAY, Ph.D., is an associate professor of Curriculum and Instruction. Contact: Çukurova University, Faculty of Education, Department of Educational Sciences, Sub-department of Curriculum and Instruction, Adana, Turkey. Email: adoganay@cu.edu.tr

relationship between mathematics and reality (Blum & Niss, 1991). Modeling is a process in which students try to solve real-life problems (Lesh & Doerr, 2003). These processes include the identification of a problem, creating a model, establishing a relationship between a mathematical model and the real problem, predicting the situation of the real problem and confirming it. In parallel to this, mathematical modeling is the simplified presentation of real-life problems by means of a mathematical model (Voskoglou, 2006). According to Cheng (2001), mathematical modeling is the demonstration of real-life problems using mathematical terms, and the process of transforming these problems into the language of math. Activities included in this process make it easy for us to see real-life problems clearly, to associate these problems with mathematical information, to classify and generalize these problems and to make a deduction (Schwarz & Kaiser, 2007; Sriraman, 2005).

According to Berry and Nyman (1998), in the mathematical modeling process, a real-life problem is first discussed in the form of a mathematical problem, then the mathematical problem is solved using known techniques, and the obtained result is then would be interpreted after being adapted to the real life situation. According to Ferreira and Jacobini (2009), mathematical modeling provides excellent opportunities for students to use their ideas in different areas and to establish logical connection; a developing the necessary mathematical information and skills for implementation with real life problems.

One of the most significant goals of mathematics education programs is to teach students developed mathematical thinking, to be good problem-solvers (Milli Eğitim Bakanlığı [MEB], 2011). In this context, mathematical modeling activities in which concepts are structured in a classroom environment instead of a conventional, operation-oriented environment are dependent upon a conceptual approach (Doerr & English, 2003; English, 2006). However, these problems are structured artificially and not connected to the environment of the problem. Because they are not fit for a true purpose, this can cause various problems for the modeling process of the students when trying to establish a relationship between real life and mathematical situations. In other words, problems related to mathematical modeling in educational programs must be well-defined and must include situations which can relate to many fields (Cheng, 2001) as well as include enriched information and help develop cognitive processes (Eric, 2009).

Mathematical modeling enables students to learn mathematics through different methods (Zbiek & Conner, 2006), to develop their skills for using mathematics in daily life, and at the same time, to bring them the skill to reflect upon what they've learned (Zbiek & Conner, 2006). Teachers have three main purposes when developing modeling activities: to reveal the thought processes of the students, to share thoughts and ways of thinking with their peers regarding the subject, and to learn how to apply these ways of thinking over multiple subjects. The modeling process is an important factor in the interpretation and perception of rich mathematical content both in terms of teachers and students, and also in the development of their thinking skills. All teachers cannot be expected to start from the same point, make the same interpretations or set up the same patterns in modeling activities (Doerr & English, 2003).

As can be understood from the previous paragraph, the activities of mathematical modeling are of vital importance for the development the mathematical perception skills of students (English, 2006; English & Watters, 2004; Zawojewski & Lesh, 2003), and the development of these skills depends on teachers (Doerr & English, 2003). Therefore, there are many responsibilities that teachers have in the process of bringing these skills to the students (Ferri & Blum, 2009; Niss, Blume, & Galbraith, 2007). However, when literature is analyzed, it can be seen that prospective teachers do face some serious difficulties in the mathematical modeling process (Blomhoj & Kjeldsen, 2006; Caldeira, 2009; Csikos, Szitanyi, & Kelemen, 2011; Çiltaş & Işık, 2013; Dowlath, 2008; Doyle, 2006; English & Watters, 2004; Eraslan, 2011; Kertil, 2008; Keskin, 2008; Mousoulides & English, 2008; Mousoulides, Sriraman, Pittalis, & Christou, 2007; Sriraman, 2005; Tekin-Dede & Bukova-Güzel, 2013). For instance, in Keskin's research (2008), he investigated the knowledge, skills and views of mathematics teacher candidates on the subject of modeling by using the analysis method. At the end of the research it was observed that mathematics teacher candidates encountered some difficulty with the test for pre-mathematical modeling. However, they also were more successful with their final mathematical modeling test after being given information and shown examples on theoretical modeling during the semester. Also, in Eraslan's research (2011) where he analyzed the model formation activities of primary school teaching candidates and the effect of these activities on mathematics education, he reached the conclusion that teacher candidates faced uncertainties during the modeling process. Similarly, Kertil (2008), as a result of the research where he investigated how mathematics teacher candidates reflected their problem-solving skills onto the mathematical modeling processes, he found out that the modeling skills of teacher candidates were not adequate enough for their problem-solving processes, and they were unfamiliar with the modeling activities. On the other hand, Dowlath (2008) investigated different strategies and models used by teacher candidates when solving their real word problems. As a consequence of his research, Dowlath revealed that the knowledge of teacher candidates on the subject of mathematical modeling was insufficient, and teacher candidates used a standard strategy when solving real word problems.

In general, in the literature, researches carried out on the subject of mathematical modeling stand out either as experimental studies (Csikos et al., 2011; Dowlath, 2008; English, 2006; Mousoulides, Chrysostomou, Pittalis, & Christou, 2009; Mousoulides, Christou, & Sriraman, 2008) or as case studies (Bukova-Güzel & Uğurel, 2010; Eraslan, 2011; Ferri & Blum, 2009; Keskin, 2008; Taşova & Delice, 2012). In this study, in order to examine the current situation about the concept of modeling, to use a new subject for teacher candidates that constitutes the sampling of this research, to determine the difficulties faced in the process, and to give education in this direction, the action research model was preferred by the researchers. In accordance with this common purpose, answers for the below questions, were sought.

1) What are the concepts and operation-oriented success levels of primary school prospective teachers in the mathematical modeling process?

2) What could be done to improve the mathematical modeling perceptions of primary school prospective teachers?

3) To what extent do the activities applied to improve the mathematical modeling perceptions of primary school prospective teachers develop the modeling perception?

Method

Research Model

This is an action research method which intends to improve the primary school prospective teachers' perception of the mathematical modeling process. This action research includes the implementation process of scientific methods in order to solve the problems faced in the classroom (Gay, 1987; Neumann, 2006). Action research is implementation oriented with the intention of finding solutions for the underlying problems (Creswell, 2008; Gay, 1987). Within this scope, Lim (2007) also indicated that action research generally includes the determination of learning and teaching oriented problems inside a classroom or school, and then offering solutions. According to Creswell (2008), action research includes the teachers or instructors in the scope of the research and systematically seeks a solution for the problems faced in the implementation process. Moreover, participants and researchers cooperate together to find solutions to the problem (Cohen & Manion, 1994).

Action research is a process that is related to problem solving, and that shows continuity (Ekiz, 2003; Neumann, 2006; Punch, 2005). In general, action research is constituted by a cycle that includes "planning," "acting," "observing," and "reflecting" stages (McNiff & Whitehead, 2002; Richards & Lockhart, 1997).

Participants

Participants in this research consisted of freshmen continuing their education in the department of primary school teaching in a state university during the 2011-2012 academic year. 47% of the participants were female and 53% were male students. When determining the participants, the criteria sampling method, one of the methods of purposeful sampling, was used. According to this method, a sampling is envisioned and determined in relation to a certain purpose or the subject being focused on (Punch, 2005). In this research, this was a group who didn't receive any education on the subject of mathematical modeling, who successfully completed the course *Basic Mathematics I* and who are interested in math class. In the mathematical modeling process, many concepts; graphics, percentage calculations, ratio and proportions, probability, equations, measurements and geometry are used. Therefore, in order to be successful at a mathematical modeling process, a student must learn these concepts (Zambujo, 1989 as cited in Keskin, 2008).

Data Collection Instruments

Data collection instruments used in the research, are composed of mathematical modeling comprehension and operational tests implemented at the beginning and end of the application as well as weekly evaluation tests prepared within the framework of activity plans (Variables test I-II, model formation tests and model analysis).

Comprehension Tests for Mathematical Modeling: When creating the comprehension tests for mathematical modeling, problems were used which included real life situations. These problems were created by utilizing the literature within the scope of the subjects of numbers, ratios, proportions, relations, functions, graphics, equations and inequalities (Cramer, 2003; Doruk, 2010; Johnson & Lesh, 2003; Keskin, 2008; Lesh & Doerr, 2003; Sağırlı, 2010; Zawojewski, Lesh, & English, 2003).

When analyzing the Comprehension Tests for Mathematical Modeling, an analytical rating scale was created by using the relevant literature (Ärlebäck, 2009; Berry & Nyman, 1998; Kertil, 2008; Keskin 2008, Panaoura, Demetriou, & Gagatsis, 2009; Sağırlı, 2010; Voskoglou, 2006). The scale variables created within this scope are composed of three categories: preference, model formation and the solution of the mathematical model. Scoring for each category ranged between 0-2.

Data Analysis

In an action research, analysis is carried out during the data collection process, and it sheds light on the type and quality of the additional data which needs to be collected. Statistical analyses were conducted using the package program SPSS 17.0 for Windows. In the analyses, mean and standard variations of the scores that the participating students made in the preliminary and final tests were also calculated.

Validity and reliability of an action research is carried out differently than in quantitative research. The internal validity, external validity, reliability and objectivity of the data, which is necessary to perform in quantitative research, is not directly applied to action research (Anagün & Yaşar, 2009). As action research focuses on local problems, the results obtained do not have to be generalized (Neumann, 2006). In addition to this, as action research focuses on a specific problem determined in a specific environment/situation, the implementation process of the method is interpreted more freely. Within this context, in the course of the validity studies in this research, researchers provided continuous communication with each other and with the two mathematics instructors. In order to check the students' level of understanding, data was continuously collected, and if learning was not considered adequate as a result of this data, the action plans were discussed and revised with the two mathematics instructors and re-implemented. In the analysis of the preliminary, in-process and final Comprehension Tests for Mathematical Modeling, a second coder was used. Reliability among the coders was found to be .91 in the preliminary comprehension test, .93 in the variable 1 test, .93 in the variable 2 test, .91 in the model formation test, .99 in the model analysis test, and .89 in the final comprehension test.

Findings

The findings obtained from the research are indicated below, oriented towards the goal of the research. Accordingly, the findings obtained by students concerning the preliminary test which was conducted in accordance with the mathematical modeling, are given in Table 1.

Table 1
Findings of Comprehension and Operational Preliminary Tests Regarding Mathematical Modeling

	Pre-comprehension test (Number of questions: 15)		Pre-operational test (Number of questions: 15)	
	$\bar{X}$	S	$\bar{X}$	S
D0	7.74	2.29	-	-
D1	1.41	1.18	-	-
D2	5.44	2.27;	-	-
M0	8.33	2.61	-	-
M1	3.41	1.42	-	-
M2	2.85	1.91	-	-
Ç0	5.18	2.84	1.00	1.56
Ç1	5.44	2.31	2.64	2.88
Ç2	3.94	2.33	11.27	4.49

D0: Variable left blank; D1: Variable misidentified D2: Variable defined correctly; M0: Model formation left blank; M1: Model formation constructed incorrectly; M2: Model formation constructed correctly; Ç0: Solution left blank; Ç1: Wrong solution; Ç2: Right solution

When Table 1 is analyzed, it can be seen that the pre-comprehension test for Mathematical Modeling was evaluated in three different categories: variable, model formation and analysis. Each category was analyzed as being left blank, done incorrectly, or done correctly. Accordingly, the average number of blank answers for the variable category in the pre-comprehension test was 7.74, the average number of incorrect answers was 1.41 and the average number of correct answers was 5.44. In the model formation category; the average number of questions left blank in the pre-comprehension test was 8.33, the average number of incorrect answers was 3.41, and

Table 2
Descriptive Findings Obtained on Variables

		Pre-comprehension test (Number of questions: 15)		Variable Test 1 (Number of questions: 10)		Variable Test 2 (Number of questions: 10)		Model formation test (Number of questions: 9)		Analysis Test (Number of questions: 10)		Final Comprehension Test (Number of questions: 15)	
		$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
D0		7.74	2.29	.24	.66	.04	.20	.79	1.01	.59	.99	1.77	2.42
D1		1.41	1.18	4.15	2.66	1.28	1.44	.03	.17	.03	.17	.03	.18
	D11	.26	.57	2.55	1.71	1.24	1.20	.00	.00	.00	.00	.00	.00
	D12	1.15	1.08	.67	.92	.64	.81	.03	.17	.03	.17	.03	.18
	D13	.00	.00	.94	.93	1.16	1.43	.00	.00	.00	.00	00	.00
D2		5.44	2.27	6.64	1.88	8.32	1.46	8.18	.99	9.38	1.10	13.19	2.40

D0: Variable left blank; D1: Variable misidentified; D11: Error originating from the parameter; D12: Error originating from the variable; D13: Error originating from the invariant; D2: Variable defined correctly.

the average number of correct answers was 2.85. In the analysis stage of the model, the average number of questions left blank in the pre-comprehension test was 5.18, the average number of incorrect answers was 5.44 and the average number of correct answers was 3.94.

On the other hand, when the results of the pre-comprehension and pre-operational tests conducted for teacher candidates were analyzed; the average number of correct answers given for the same questions within the scope of the comprehension test was 3. 94, and the average number of correct answers for the pre-operational test in which the models were given was 11.27. Based on these results, action plans were prepared in order to determine the variables and resolve the problems faced in the formation of mathematical models. The initial action plan focused on the variables. Because the results of variable Test 1 were inadequate, a second action plan on the same subject was prepared. Following the second action plan, variable Test 2 was conducted.

When Table 2 is analyzed, the average number of blank answers in the pre-comprehension test was 7.74, the average of incorrect answers was 1.14, and the average of correct answers was 5.44. As a result of the implementation of the initial action plan, the average number of wrong answers out of 10 questions in the Variable Test 1 category was 4.15, and the average number of correct answers was 6.64. As a result of these findings, the subject of variables was considered to be not fully comprehended, so a second action plan was implemented. According to the obtained results, it was found that the average number of wrong answers out of 10 questions was 1.28, and the average number of correct answers given by students concerning the variable was 8.32.

Again, following the third action plan implemented on the subject of model formation, the Model Formation Test was prepared. In the evaluation phase of this test, teacher candidates' ability to identify the variables was analyzed. When Table 2 is analyzed, it can be seen that 8.18 out of 9 questions within the scope of the Model Formation Test were answered correctly. In the fourth action plan, the subject of analysis was discussed. Following the fourth and final action plan, it can be clearly seen that regarding the variables within the scope of the Analysis Test, teacher candidates answered 9.38 out of 10 questions correctly. Finally, following the completion of the action plans, it can be seen in Table 2 that 13.19 out of 15 questions asked in the Final Comprehension Test were answered correctly. The scores acquired by the teacher candidates for

Table 3
Descriptive Findings Obtained on Model Formation

		Pre-comprehension test (Number of questions: 15)		Model formation test (Number of questions: 9)		Analysis test (Number of questions: 10)		Final Comprehension test (Number of questions: 15)	
		$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
M0		8.33	2.61	.74	.79	.88	1.32	3.13	3.16
M1		3.41	1.42	.00	.00	.18	.46	.84	1.25
	M11	.76	.78	.00	.00	.09	.29	.16	.45
	M12	2.64	1.39	.00	.00	.09	.38	.68	1.14
M2		2.85	1.91	8.26	.79	8.94	1.52	11.03	3.38

M0: Model formation left blank; M1: Model constructed incorrectly; M11: lack of concept, uninformed about the subject; M12; Error in model formation; M2: Model constructed correctly

Table 4
Descriptive Findings Obtained on the Subject of Analysis

		Pre-comprehension test (Number of questions: 15)		Pre-operational test (Number of questions: 15)		Analysis test (Number of questions: 10)		Final comprehension test (Number of questions: 15)		Final Operational test (Number of questions: 15)	
		$\overline{X}$	S	$\overline{X}$	S	$\overline{X}$	S	$\overline{X}$	S	$\overline{X}$	S
Ç0		5.18	2.84	1.00	1.56	1.12	1.27	3.19	2.74	.00	.00
Ç1		5.44	2.31	2.64	2.88	.29	.58	1.00	1.51	1.49	1.36
	Ç11	1.29	1.22	.00	.00	.06	.24	.19	.65	.00	.00
	Ç12	.32	.73	2.61	2.88	.00	.00	.68	1.11	1.49	1.36
	Ç13	.50	.51	.03	.17	.09	.29	.06	.25	.00	.00
	Ç14	3.32	1.72	.00	.00	.18	.46	.06	.25	.00	.00
Ç2		3.94	2.33	11.27	4.49	8.59	1.37	10.81	2.99	13.51	1.36

Ç0: Solution left blank; Ç1: Error in the solution; Ç11: Single data used; Ç12 Calculation error; Ç13 Logic error; Ç14: Error originating from the model; Ç2: Right solution

the pre-comprehension, model formation, analysis and final comprehension tests regarding the subject of model formation are given in Table 3.

When Table 3 is analyzed, it can be seen that the average number of questions left blank was 8.33, the average number of wrong answers was 3.41, and the average number of correct answers was 2.85. It is also seen that 0.74 of 9 questions answered at the end of the third action plan implemented in the model formation category were left blank and 8.26 were answered correctly.

Scores acquired by the teacher candidates for the pre-comprehension, model formation, analysis and final comprehension tests regarding the subject of analysis are given in Table 4.

When Table 4 is analyzed, it can be seen that the average number of questions out of 15 in the pre-comprehension test which were left blank was 5.18, the average number of wrong answers was 5.44, and the average number of correct answers was 3.95. For the pre-operational test, it is seen that 1 of 15 questions was left blank, the average number of wrong answers was 2.64, and the average number of correct answers was 11.27. At the end of the fourth action plan for the analysis category, of the 10 questions asked, the average number of wrong answers was 1.12, and the average number of correct answers was 8.59. As a result of the final comprehension test, it can be clearly seen in Table 4 that out of 15 questions, the average number of questions left blank was 3.19, and the average number of correct answers was 10.81. In addition, it can also be seen that out of the 15 questions asked in the final operational test, 13.51 were answered correctly.

Scores related to the final comprehension and operational tests on the subject of mathematical modeling carried out for teacher candidates after the action plans were completed are given in Table 5.

Table 5
Final Comprehension and Operational Test Findings Related to Mathematical Modeling

	Final comprehension test (Number of questions: 15)		Final operational test (Number of questions: 15)	
	$\overline{X}$	S	$\overline{X}$	S
D0	1.77	2.42	-	-
D1	.03	.18	-	-
D2	13.19	2.40	-	-
M0	3.13	3.16	-	-
M1	.84	1.24	-	-
M2	11.03	3.38	-	-
Ç0	3.19	2.74	.00	.00
Ç1	1.00	1.51	1.49	1.36
Ç2	10.81	2.99	13.51	1.36

D0: Variable left blank; D1: Variable misidentified D2: Variable defined correctly; M0: Model formation left blank; M1: Model formation constructed incorrectly; M2: Model formation constructed correctly; Ç0: Solution left blank; Ç1: Wrong solution; Ç2: Right solution

When Table 5 is analyzed, it can be seen that just as with the final and preliminary comprehension tests, mathematical modeling was evaluated in three categories: variable, model formation and analysis. Accordingly, the average number of correct answers given to the 15 questions for the variable category of the final comprehension test was 13.19. The average number of correct answers given for the model formation category was 11.03. The average number of correct answers given for the model analysis stage was 10.81. Lastly, it can be clearly seen that 13.51 of the questions asked for the final operational test were answered correctly.

Discussion and Conclusion

This study was carried out in order to determine the successfulness of concept and operation orientation of the primary school prospective teachers for mathematics modeling processes, and to reveal to what extent the activities conducted in the course of this process improved the understanding of modeling.

According to the findings from the pre-comprehension test, the average number of correct answers given to 15 questions in the test was 3.94, and the average number of correct answers given to 15 questions in the pre-operational test was 11.27. Accordingly, it can be said that students' success with mathematical modeling was quite lower than their operational success. In many researches that have been conducted (Çiltaş, 2011; English & Watters, 2004; Sicignano, 2011; Taşova & Delice, 2012; Uçar, 2011), it is pointed out that the conceptual knowledge of students is inadequate. In his research, Uçar (2011) pointed out that teacher candidates' perception of mathematical concepts on several subjects was inadequate and that their mathematical knowledge was incorrect. In his research, Çiltaş (2011) analyzed the mathematical modeling skills of primary school teacher candidates that were educated on the subject of series and sequences using the mathematical modeling method. As a result of his study, he found out that teacher candidates had difficulties learning the concepts related to series and sequences, and they were not able to create models regarding these concepts.

When the literature is analyzed, it can be seen that a student's success regarding their operational skills is much higher than their success regarding their understanding of the concepts, which is in parallel with the findings of this research (Çiltaş, 2011; Delice & Sevimli, 2010; English & Watters, 2004; Ghazali & Zakaria, 2011; Sicignano, 2011; Taşova & Delice, 2012; Tekin, 2008; Zakaria & Zaini, 2009). For instance, Ghazali and Zakaria (2011) analyzed the conceptual and operational knowledge of students regarding algebra, and they found out that the scores acquired by students from the operational test were very high. However, they acquired much lower scores in the comprehension test. Similarly, in his research in which he tried to reveal the conceptual and operational knowledge structure of students, Tekin (2008) reached the conclusion that students answered the majority of questions correctly which related to operational knowledge, yet they answered the majority of questions incorrectly which involved conceptual information. In his research, Sicignano (2011) reached the conclusion that even though the teachers had a learning environment in which the conceptual information and/or operational information was provided, they were not able to use a conceptual method for teaching. Moreover, Sicignano also found out that even though the teachers requested a teaching system in which they could implement conceptual and operational information together, the field information they had on this subject was not adequate. Again, in their research, Delice and Sevimli (2010) pointed out that the students could easily perform calculation operations, yet they had difficulty in providing conceptual information, which has a definitive role in the operational process.

There could be several reasons why a student's success with mathematical operations is much higher than their success with conceptual understanding: It can be said that this is the consequence of making math courses operation-oriented and not performing enough studies in order to reveal their mathematical thought processes. Other reasons could be that the operational knowledge of the participating teacher candidates was at the forefront of the research, or that there is an absence of teaching concepts qualitatively in order to develop their mathematical efficiency during their undergraduate education. For this point, faculties that teach teachers have a most important responsibility. Accordingly, the concepts which are required to be learned by teachers during their undergraduate education are concepts suitable for students to understand the teaching process, and education programs should reconsider which subjects are useful.

Aside from that, the mathematics modeling stages of the students were evaluated in the research in three different stages: variable determination, model formation and analysis of the model created. On average, in the preliminary test which was composed of 15 questions, it was found that during the variable determination stage, students answered 5.44 questions correctly, during the model formation stage, they answered 2.85 questions correctly, and in the analysis stage, they answered 3.94 questions correctly. In this test, which was conducted without giving any information about the modeling, it was observed that the majority of students were not able to create mathematical modeling. This result is similar to the results of other researches carried out on mathematical modeling

(Bukova-Güzel & Uğurel, 2010; Çiltaş, 2011; Dowlath, 2008; Eraslan, 2011; Ikeda & Stephens, 2010; Kertil, 2008; Keskin, 2008; Sağırlı, 2010). For instance, in Eraslan's study (2011), he analyzed the activities of model formation and primary school math teacher candidates' views about the effects of these activities' on mathematics teaching. In this research, it was discovered that if activities in the mathematical modeling process included concepts different from what the teacher candidates were accustomed to, they faced uncertainties in their analysis processes.

Finally, in the research, it was observed that the activities which were performed to develop the students' knowledge about mathematical modeling did improve the modeling comprehension in a positive direction. In literature, it can be seen that similar results were obtained from the researches carried out on this subject (Ärlebäck, 2009; Bukuva-Güzel, 2011; Çiltaş, 2011; Doruk & Umay, 2011; English, 2006; English & Watters, 2004; Eraslan, 2011; Ikeda & Stephens, 2010; Keskin, 2008; Lingefjard, 2002; Mousoulides et al., 2008; Sağırlı, 2010; Schwarz & Kaiser, 2007; Zbiek & Conner, 2006). Within this context, Bukuva-Güzel (2011) in their research analyzed the modeling problems and solution phases at the end of the semester as prepared by a group of students who had taken a mathematical modeling course,. As a result of the research, Bukuva-Güzel realized that the problems created by students were related to daily life and were intriguing. This made the modeling process more understandable and also allowed it to be simplified. As a result of the implementation of the experimental education program, Ikeda and Stephens (2010) also reached the conclusion that knowledge of students regarding modeling has made positive progress.

When the relevant literature is analyzed, researches that did not show similarity with these findings were also encountered (Dowlath, 2008; Frejd, 2012; Sağırlı, 2010). For instance, Dowlath, (2008) analyzed the different strategies and mathematical modeling processes used by teacher candidates in South Africa in order to resolve their real life problems. As a result of carrying out the experimental study, it was seen that teacher candidates' skills for resolving real life problems were inadequate, and they were not able to create mathematical modeling. In his study, Frejd (2012) analyzed the views of eighteen teachers regarding the implementation processes of modeling activities in the classroom. As a result of the research, he reached the conclusion that teachers were not able to associate mathematical modeling activities with their courses. Frejd points out that this might be due to the teachers' lack of experience with mathematical modeling, the absence of adequate information or ideas on this subject, or because they did not receive any such education in their undergraduate study.

Based on the findings mentioned above, it is seen that the success of participant primary school prospective teachers with regard to mathematical comprehension and modeling, was increased by means of the activities carried out during the mathematical modeling process, and that the education provided during this process was also effective. Within this context, it can be clearly understood that it is especially important for primary school teacher candidates to gain experience with the mathematical modeling process in order to understand the mathematical concepts and to create modeling. Accordingly, the concept of mathematical modeling might be utilized in basic mathematics or math lessons, and a course regarding mathematical modeling might also be included within the education programs. In addition, in-service education that would bring information and skills regarding modeling by means of different applications and projects might also provided for the class teachers. Aside from this, it is obvious that concentrating on mathematical thinking instead of operation skills in mathematics education should be required beginning from the first year of a mathematical teacher's education.

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