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THE EVALUATION OF THE PROBLEM SOLVING IN MATHEMATICS COURSE ACCORDING TO STUDENT VIEWS

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Abstract. This study was conducted to determine the problem solving skills of the third grade students studying at the department of elementary school mathematics teaching. The study was conducted in the second semester of the academic year of 2015-2016. The study group consists of 47 third year student who study at Ondokuz Mayıs University, Faculty of Education Elementary School Mathematics Teaching ad take the selective course of Problem Solving in Mathematics. Within the scope of this course, the researchers explained subjects related to problem and problem solving, problem solving skills and solved problems during the first 4 weeks of the course. For the rest of the weeks, the students were divided into groups. They have solved two non-routine problems each week for 8 weeks. The method of study is the interview method, which is one of the qualitative research methods. In light of the retrieved findings, the answers given by the students have been thematized as the stages of problem solving, understanding the problem, implementing the problem, evaluation of the problem, reasons for taking the courses, association problems, ways of finding different solutions, development of procedural skills, creating formulas, mathematical thinking, use of mathematical language, suitability of the course, views on problem solving, and the contribution of the course. Keywords: Problem, Problem solving, Mathematics, Polya

1. Introduction

The expectations from individuals change with the lifestyles, improving technology and requirements. It is thought that the individuals who will adapt to the environment lived in should be trained as individuals who know problem solving, self and environment aware, solution oriented and practical. [42] states that the way of raising an individual is through the adoption of an understanding of an educational system that solves the events, able to see the relationships between the events, and establish cause-effect relationship, gaining problem-solving and reasoning. The objective in education should be to train individuals who use old information, conceptualization, analysis and synthesis with creativity to obtain new information. [32] in the traditional mathematics teaching, teachers were teaching students by giving information in pieces, but the new understanding is to teach mathematics

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by doing mathematics. [26] stated that operative knowledge is not enough in problem solving in accordance with new understanding, students knowing this are not sufficient to be good problem solvers. In order to be a problem solver, it is necessary to understand and identify the problem well.

Problem can be defined as mind confusing [15], characterized as obstacle and difficulty [23] the effort made to reach a certain objective [9, 41] and what is done in the process of overcoming the obstacle. To solve the existing problems, problem solving must be known. Problem solving was reported by [16] and [24] as a complex process containing affective and behavioral prowess as well as cognitive skills, and besides, it can be observed due to being a mental process. Problem solving can be defined for mathematics lesson as the process of perceiving real life, adapting and using mathematical skills in daily life, recognizing numbers [46] being open-minded, creative [44] classification, making comparisons, perceiving mathematical concepts [19].

When the literature is examined, the most accepted four-step process in the problem solving process is as follows. Understanding the problem, strategy selection, application of selected strategy and evaluating the solution [2,8,20,35,36,37]. It is very important that these steps are well known by teacher candidates. These stages are in fact the basic conditions for the student to become a good problem solver. It is necessary to structure the step of understanding the problem well. In the step of understanding the problem, [8] stated that writing the given and required in the problem, explaining the problem with the student's own expression, and drawing a shape suitable for the problem is necessary. The student should also know the strategy on how a problem is solved to become a good problem solver. When the literature is examined, the most accepted four-step process in the problem solving process is as follows. Creating flow chart, utilizing solutions of similar simple problems, trial and error, using and writing equations, eliminating and drawing diagrams, do what is needed, eliminating unnecessary data, work retrospectively, solving by drawing graphs selecting operation, using materials, modeling, model making, reasoning reasoning, search for pattern, relation, finding, expressing the problem in different way, simplifying the problem, simplification, solving a part of a problem, creating a systematic list, using figures and images solving by creating at able guessing, guesswork and checking, using assumptions, finding insufficient data [2]

[8,17,20,21,27,35,36] These strategies can be taught only by solving the problems according to these strategies and making practices. For this purpose, in this study, problem situations that students can solve with the strategies listed above are shown to them every week, solved by applying one by one, and solutions are presented in the process.

When the literature on cognitive field studies is examined, it is known that students who actively participate in the process better understand the process [49]. That is why students must be taught how to reach the source of information and the knowledge on how to solve them must be given. [45] stated that problem-solving behaviors should be gained to students. Most students develop new problem solving strategies by observing problem solving examples of other people [11]. Therefore, it is known that leaving the students alone with the problem situations that can be solved with different strategies will be good for the development of this skill. [31] stated that if the teacher constantly solves the problem that the students should solve, they will prevent the students from developing their problem solving behaviors. In this respect, it is important for the teacher to be a good problem solver, teach how to explain problem solving in terms of teaching this to younger age groups. Therefore, it is thought that it will be beneficial for the students to be educated in this way while being a teacher candidate during the undergraduate period. It is important to do this study in terms of seeing whether the students think this way before and after the process.

The problem of this research aims to reveal the opinions of 3rd grade students studying at Ondokuz Mayıs University Faculty of Education Primary Education Mathematics Teaching about the lesson, problem situations, problem solving and problem solving skills before and after taking the elective lesson of problem solving in Mathematics. In this way, the feelings and thoughts of students towards the lesson and the ideas against the problems will be learned. While contributing to the course to be given in the next semester, it also has a qualification as a study to be a guideline for other researchers who give this course.

2. Metot

In this section, information on the pattern, study group, process, data collection tool and analysis of study are given.

2.1. Working Design

The research method of this study is interview, one of the case study patterns in accordance with the nature of the qualitative study. [48] stated that the method used mainly is interviewing from the qualitative research methods. [18] stated that the interview was a method used to reveal the opinions, thoughts, interests, attitudes and behaviors of students about various subjects and their causes. The interview is a method of gathering information by taking the answers of the closed-ended to open-ended questions asked to related persons [29]. [38] stated that interview is more than a method where only answers to questions were found and hypotheses were tried to be evaluated. Because with the interview, he stated that a person's experiences with other people, the meanings from their experience, symbolize the feeling of curiosity. [25] stated that the view is a careful inquiry and listening process.

2.2. Study Group

The study was conducted in the second semester of the academic year of 2015-2016. The study group consists of 47 third year student who study at Ondokuz Mayıs University, Faculty of Education Elementary School Mathematics Teaching ad take the selective course of Problem Solving in Mathematics.

2.3. Process

Within the scope of this course, the researchers explained subjects related to problem and problem solving, problem solving skills and solved problems during the first 4 weeks of the course. For the rest of the weeks, the students were divided into groups. They have solved two non-routine problems each week for 8 weeks. At the end of each course the problems solved were discussed and the problem situations were dealt within the scope of Polya's problem solving stages.

2.4. Data Acquisition Tool and Analysis

The data collection tool of this work is a semi-structured interview form. The semi-structured interview form was prepared by researchers. The interview form consists of 20 questions. Two interviews were conducted before and after the implementation. The data obtained with the interview form data collection tool were analyzed by inductive analysis method. Codes were developed for content analysis and inductive analysis of probable categories and themes were made [34]. This method is also called open coding [40]. After establishing categories and themes in inductive analysis, it is appropriate to perform deductive analysis [40] in the validation phase, the last stage of the qualitative research, and in the phase of data not matching the categories.

3. Findings

In the light of the findings, the answers of the students were themed as the stages of problem solving, understanding the problem, application of the problem, evaluation of the problem, problem solving stages, reasons for taking the lessons, forming relationship difficulties, finding different solution paths, proactive inhibition, reasoning skills, formula creating, mathematical thinking, solution ways, development in procedural skills, using

mathematics language, suitability of the course, thoughts on problem solving, the contribution of the lesson. The categories and codes belonging to the theme are listed below.

3.1. Problem solving stages

Table 1. Analysis of data according to the stages of problem solving

	Pre-Implementation				Post-Implementation		
Theme	Category	Code	f	%	Code	f	%
Problem solving stages	The areas in which students feel insufficient in terms of their problem soling skills	Directly solving by reading	16	34,0			
		I did not use problem solving stages	18	38,2			
		I solved them in a solution-oriented way	8	17,0			
		From my mind, through multiple-choice logic	13	27,6			
		With no rules	4	8,5			
		By roughly working on it, not in a systematic way	6	12,7			
	The areas in which students feel sufficient in terms of their problem solving skills	Logical reasoning	4	8,5	Understanding the problem	43	91,4
		Drawing figures	3	6,3	Writing down the information	43	91,4
		Creating an equation	3	6,3	Writing down what is asked	43	91,4
		Listing	1	2,1	Strategy selection	43	91,4
		Drawing a Diagram	1	2,1	Implementation of the strategy	43	91,4
		Creating a list	1	2,1	Evaluation of the solution	43	91,4
		Writing down the given information	1	2,1	I use all stages	42	89,3
		Writing down what is asked	1	2,1	I think of methods convenient for the solution when I read the question	5	10,6
					Writing down an equation/inequation	2	4,2
					Estimation control	4	8,5
					Drawing a table	2	4,2
					Drawing a Diagram	2	4,2
					Making a systematic list	1	2,1
					Logical reasoning	1	2,1
					Drawing figures	1	2,1
					I write down all methods and check them	1	2,1

The table demonstrates that there are two categories for students' views for the pre-implementation of problem solving stages and one category for the post-implementation views of students. The pre-implementation views are examined in two categories including the areas in which students feel insufficient in terms of their problem solving skills and the areas in which students feel sufficient in terms of their problem solving skills. It was observed that in the pre-implementation phase, the majority of them only read and solved the problem and did not use the problem solving stages, whereas; in the post-implementation phase, the majority of the students solved the problems by paying attention to the problem solving stages of Polya. Furthermore, it was detected that in both the pre-

implementation and the post-implementation phases, they solved the problems by employing strategies such as drawing a figure, creating a diagram, and making a list.

3.2. Data analysis based on the stage of understanding the problem

Data analysis based on the stage of understanding the problem and the categories and codes belonging to the theme are listed below.

Table 2. Data analysis based on the stage of understanding the problem

	Pre-Implementation				Post-Implementation		
Theme	Category	Code	f	%	Code	f	%
Understanding the problem	Making use of the data	Considering what is asked	16	34,0	Finding what is given in the question	42	89,3
		Considering the data	11	23,4	Writing down what is asked	42	89,3
					Distinguishing between the necessary and unnecessary information	8	17,0
	Problem types / Subject knowledge	By drawing	5	10,6			
		By establishing a connection among data	4	8,5			
		Reasoning	1	2,1			
	Deficiencies in Understanding/ Errors	By repeatedly reading	15	31,9			
		By mentally making operations	14	29,7			
		I would solve them only in a solution-oriented way	7	14,8			
		I had difficulty with understanding the problem	4	8,5			

Table 2 suggests that students primarily made use of the data at the stage of comprehending the problem. This only involved looking at what is given and asked in the question at the pre-implementation phase, however, at the post-implementation phase, it also involved writing down what is given and asked in the question as well as distinguishing between the necessary and unnecessary information. In the pre-implementation phase, the students also tried to draw what is given in the question and create a link between them. The errors or insufficiencies observed in the pre-implementation phase include solving the problem by reading it over and over again, mentally making mathematical operations, trying to solve the problem by looking at the solution in a solution-oriented way, not solving the question as a result of having difficulty with understanding the problem, yet, in the post-implementation phase these errors or insufficiencies were overcome.

3.3. Problem implementation

Problem implementation and the categories and codes belonging to the theme are listed below.

Table 3. Data analysis based on the stage of problem implementation

	Pre-Implementation				Post-Implementation		
Theme	Category	Code	f	%	Code	f	%

Problem Implementation	Planning the solution	By thinking of how to solve the question through the use of the given information	19	40,4	Strategy selection according to the given information and what is asked in the question	45	95,7
		Logical reasoning	2	4,2	Solution plan that is convenient for the strategy	12	25,5
		I solved them in a solution-oriented way	13	27,6	By evaluating all 8 strategies	1	2,1
		I solved them based on certain patterns	3	6,3			
	Deficiencies in Understanding/ Errors	I did not implement the strategy	24	51,0	Level of knowledge about the selected strategy	3	6,3
		I start making operations before understanding	9	19,1			
		Without properly reading	4	8,5			
		I solved them through multiple-choice logic	4	8,5			
		By roughly drawing	2	4,2			
		Without paying attention to Polya's stages	1	2,1			
	Understanding the problem	By writing an equation	4	8,5	Finding a connection	1	2,1
		By drawing a diagram	3		Making a systematic list	1	2,1
		By drawing figures	2	4,2	Drawing a table	1	2,1

Looking at the Table 3, there are three categories in the problem implementation stage including planning the solution, deficiencies in understanding/errors, and understanding the problem. It was found out that they implemented the solutions to the problems by thinking of how to solve the question through the use of the given information, through logical reasoning, by solving the problem in a solution-oriented way, and solving them based on certain patterns. In the post-implementation phase, they approached the questions by selecting the suitable strategy by looking at what is given and expected in the question, developing a solution plan convenient with the strategy, and evaluating the eight different strategies they learned. In terms of the errors and deficiencies, in the pre-implementation phase, it was observed that they did not implement strategies, started operating without understanding, roughly drawing, and solved via multiple choice logic without paying attention to Polya's stages. In the post-implementation phase, they expressed that they approached the question after selecting the strategy based on how competent they are with that strategy. In the implementation phase, it was observed that they tried to write equations, to draw diagrams and figures so as to understand the problem. Similarly, they expressed that in the post-implementation phase, they implemented the solution to the problem by finding a link, making a systematic list, and drawing a table.

3.4. Evaluation of the Problem

Evaluation of the problem and the categories and codes belonging to the theme are listed below.

Table 4. Data analysis based on the stage of evaluation of the problem

	Pre-Implementation				Post-Implementation		
Theme	Category	Code	f	%	Code	f	%
Problem Evaluation	Positive	Crosschecking	27	57,4	Crosschecking	25	53,1
		Reaching retroactively	3	6,3	Evaluation of the solution	19	40,4

		Is it convenient for the solution to the problem?	1	2,1	I evaluate them by solving other problems of the same kind	15	31,9
					I can give assignments	13	27,6
					Studying retroactively	7	14,8
					Solving the problem through different strategies	6	12,7
					Verbal explanation	6	12,7
	Negative/ False	I do not evaluate	16	34,0	The easiest part is the evaluation	2	4,2
		By looking at the answer key	4	8,5	Generalization	4	8,5
		I evaluate if I am not sure of the accuracy of the solution	4	8,5			
		I crosscheck if I am not sure	2	4,2			
		I do it if I have time	1	2,1			
	Evaluating a different person	By giving classic questions	2	4,2	Written evaluation	2	4,2
		Giving a grade	2	4,2			
		By conducting an exam	1	2,1			

Examining the Table 4, it becomes apparent that there are three categories analyzed at the problem evaluation phase including positive, negative, and evaluating a different person. Primarily, it is demonstrated in the table that evaluations were conducted at the pre-implementation and post-implementation phases. Crosschecking, working retroactively, and evaluation of the solution were carried out both prior to and after the implementation. At the post-implementation phase, it was found out that other methods such as solving other problems of the same kind, giving assignments, and verbally explaining were also used. In the negative and false section, the majority of the students used expressions such as "I do not evaluate", "I evaluate by looking at the answer key", "I evaluate if I am not sure of the accuracy of the solution', "I crosscheck if I am not sure", and "I do it if I have time". In the post-implementation phase, they uttered that the evaluation part was the easiest and simplest part and they evaluated by making generalizations. The students, who perceived problem evaluation as evaluating a person, mentioned that they would use techniques such as giving classic questions, giving a grade or conducting an exam, however, they changed their perspective in the post-implementation phase and stated that they may make a written evaluation in future.

3.5. Problem solving stages

Problem solving stages and the categories and codes belonging to the theme are listed below.

Table 5. Data analysis based on the stage of problem solving stages

	Pre-Implementation				Post-Implementation		
Theme	Category	Code	f	%	Code	f	%
Problem solving stages	Right approach	Detecting the given information	15	31,9	Understanding the problem	45	95,7
		Detecting what is asked in the question	14	29,7	Strategy selection	45	95,7

		Writing an equation	6	12,7	Implementation of the strategy	45	95,7
		Creating an equation	6	12,7	Evaluation of the solution	45	95,7
		Logical reasoning	5	10,6	Polya's stages	1	2,1
		Solving through a scheme	5	10,6			
		Mentally solving	4	8,5			
		Drawing a table	4	8,5			
		Drawing figures	4	8,5			
		Drawing a Diagram	3	6,3			
		Estimation control	2	4,2			
		Making a systematic list	2	4,2			
		Finding a connection	2	4,2			
		Using variables	2	4,2			
	False approach	I did not have these stages	9	19,1			
		My approach would be solution-oriented	8	17,0			
		I implement it without selecting a strategy	7	14,8			
		I would solve it by marking x as the unknown	6	12,7			
		Using the evaluation part	4	8,5			
		Reading the question for many times	3	6,3			

Looking at the Table 5, it can be observed that there are two approaches towards problem solving including the right approach and the false approach. The right approach involves those, who solved the question by paying attention to Polya's stages. The false approach includes not using Polya's stages, solving the problem in a solution-oriented manner, solving the questions by using similar solutions without selecting a strategy, solving by marking x as the unknown in an equation, not using the evaluation stage, and wasting time on repeatedly reading the question. In fact, they have various false approaches here. In the post-implementation phase, it was observed that almost all of the student realized how to solve the questions by using right approaches.

3.6. Reasons why they take the course

Reasons why they take the course and the categories and codes belonging to the theme are listed below.

Table 6. Data analysis based on the stage of reasons why they take the course

Theme	Category	Code	f	%
Reasons Why They Take the Course	Personal Development	Solving the problems in a better way	40	85,1
		For learning the problem solving methods	11	23,4
		Because I believe problem solving will be a guide for me	7	14,8
		Learning the methods	2	4,2
		How do I solve a problem more easily	2	4,2
		Failing at solving mathematical problems	1	2,1

		For learning a subject I dislike	1	2,1
	Liking	Becauase of the teacher	5	10,6
		I thought the course would be enjoyable	3	6,3
		Because it greatly attracted my attention	1	2,1
	Professional Development	For being useful for students throughout the problem solving process	18	38,2
	Obligation	Because other elective courses are too irrelevant to me	3	6,3
		The system appointed me	1	2,1
		I had no reason to take this course, I understood its value once I started taking it	1	2,1

Taking a look at the reasons why students take the elective course, it is seen that they generally select it because it is related to personal development. Moreover, it was detected that some of the reasons were due to liking, professional development, and obligation. In the personal growth section, the reasons why students take this course can be listed as solving the problems in a better way, learning the problem solving methods, believing problem solving will be a guide for them, viewing themselves as unsuccessful at this course, and learning this course which is regarded as an disliked subject. Moreover, some other reasons were believing the course would be enjoyable, liking the teacher, and considering the course as an attention-grabbing one. Also, the course's being the best alternative available, and the fact that the system appointed this course to them, and taking this course for no reason are some of the other reasons why students took this course.

3.7. Finding a different solution

Finding a different solution and the categories and codes belonging to the theme are listed below.

Table 7. Data Analysis Based on the Stage of Finding a different solution

Theme	Category	Code	f	%
Finding a different solution	Found		17	36,1
		I usually found a different solution	9	19,1
		I find different solutions by using reasoning skills	2	4,2
		It depends on the question	2	4,2
		I find different solutions by drawing tables	1	2,1
		I find different solutions by creating a list	1	2,1
	Requires time	It usually is the same	17	36,1
		I make trials to find different solutions	7	14,8
		I cannot find different solutions yet	2	4,2
		I need to practice	1	2,1

Examining the data from the perspective of finding different solutions, it is seen that there are students who found it and who required time. The expression of the majority of them stated that they sometimes found a different solution, again an equal number of students mentioned that they found the same solution with the rest of their classmates. A small number of students never found a different solution, however, one of them uttered that he/she would require practice and may find a different solution afterwards.

3.8. Data analysis based on the level of using reasoning skills

Data analysis based on the level of using reasoning skills and the categories and codes belonging to the theme are listed below.

Table 8. Data analysis based on the stage of data analysis based on the level of using reasoning skills

Theme	Category	Code	f	%
Reasoning skills	Positive	I do not experience difficulty	27	57,4
		I can use reasoning skills	13	27,6
		Reasoning is my job	3	6,3
		I am a "thinking" person	3	6,3
		I like handling problems	1	2,1
	Negative	Sometimes	7	14,8
		I have concerns about expressing these stages	1	2,1
		I use them in accordance with multiple-choice logic	1	2,1

Evaluating themselves in terms of their reasoning skills, the majority of the students stated that they did not experience difficulty with reasoning and they used their reasoning skills. Additionally, some of the students mentioned that they had concerns with expressing the reasoning stages and used them in accordance with multiple-choice logic without thinking about it.

3.9. Data analysis based on the level of using formula developing skills

Data Analysis Based on the Level of Using Formula Developing Skills and the categories and codes belonging to the theme are listed below.

Table 9. Data analysis based on the data analysis based on the level of using formula developing skills

Theme	Category	Code	f	%
Developing a formula	Positive	I develop them by establishing a connection	31	65,9
		I develop formulas	13	27,6
		I figure out the general formula through the given information	8	17,0
		I create formulas by looking at basic sample problems	3	6,3
		I develop formulas by generalizing	3	6,3
		I develop formulas by making a systematic list	2	4,2
		I can develop the formulas I had forgotten	1	2.1
		I can formulize it if there is a convenient pattern	1	2.1
	Negative	I use what is available	3	6,3
		I cannot develop formulas	1	2.1

Analyzing the data in terms of the level of using formula developing skills, the majority of the students are able to develop formula by establishing a connection, using the given information or generalizing and making a systematic list. They stated that if there is a pattern they could develop a formula through the solution of a simple problem. 4 students uttered negative views on the situation. These students said that they used the existing methods and did not develop new formulas.

3.10. Data analysis based on the level of using mathematical thinking skills

Data analysis based on the level of using mathematical thinking Skills and the categories and codes belonging to the theme are listed below.

Table 10. Data analysis based on the level of using mathematical thinking skills

Theme	Category	Code	f	%

Mathematical thinking	Positive Impact		47	100
		Solving step by step improved my mathematical thinking	13	27,6
		I realized how to use the mathematical language	2	4,2
		It enabled me to discover the existence of language	1	2,1
			1	2,1

Analyzing the data in terms of the level of using mathematical thinking skills, they mentioned that the process had a positive impact on them and solving the problem stage by stage improved their mathematical thinking. Furthermore, they stated that during this process they realized how to use the mathematical language.

3.11. Data analysis based on the level of using solutions

Data analysis based on the level of using solutions and the categories and codes belonging to the theme are listed below.

Table 11. Data analysis based on the level of using solutions

Theme	Category	Code	f	%
Solutions	Those who thought of all solutions	I think of some of them all solutions	27	57,4
		I think of some of them at the same time	3	6,3
	Trial-Error	I try one of them, if it fails, I try another one	6	12,7
		I implement the first solution I think of	4	8,5
	Deficient/false behavior	I do not try them all	4	8,5
		I try to solve them by using the strategies I like	2	4,2
		I do not think of all of them	2	4,2

Evaluating the data in terms of their level of using solutions, it becomes apparent that there are students, who considered all of the solutions available in the process, as well as students, who still used the trial-error method and demonstrated false of insufficient behaviors.

3.12. Data analysis based on the development level of operation skills

Data analysis based on the development level of operation skills and the categories and codes belonging to the theme are listed below.

Table 12. Data analysis based on the development level of operation skills

Theme	Category	Code	f	%
Development Level of Operation Skills	Those who think their operation skill has improved	My operation skills improved	42	89,3
		My skills improved while using the given information and what is asked in the question	4	8,5
		They improved because the process goes step by step	3	6,3
		They improved because we used different strategies	2	4,2
		Our practical operation strength increased	1	2,1
		It improved our ability to explain	1	2,1
		Rather than our operational skills, our methodological approach improved	1	2,1
		Our interpretation strength increased	1	2,1
	Those who think their operation skills did not improve	I am ineligible	1	2,1

Examining the students in terms of their operation skill levels, it is observed that the majority of them believe that their operation skills improved. Moreover, there are some

students whose methodological skills improved besides their operational skills. One student still does not feel sufficient, thus believes his/her skills did not improve.

3.13. Data analysis based on the level of using mathematical language

Data analysis based on the level of using mathematical language and the categories and codes belonging to the theme are listed below.

Table 13. Data analysis based on the level of using mathematical language

Theme	Category	Code	f	%
Using mathematical language	Those who can use mathematical language	I use mathematical language	42	89,3
		I used the given information while writing mathematically	6	12,7
	Those who do not use mathematical language	It is not something that can be immediately learned	2	4,2
		I find myself ineligible	2	4,2
		I did not make any progress about this subject in this course	1	2,1
	Those who tried using it	We tried to use it	2	4,2
		We paid attention to using it	3	6,3

Analyzing the data based on the level of using mathematical language, the majority of them in fact uses mathematical language. However, some of the students argued that this process cannot be immediately learned, thus they did not see any progress. There were students, who tried to use the mathematical language during this process.

3.14. Data analysis based on the competency level for the first mathematics course

Data analysis based on the competency level for the first mathematics course and the categories and codes belonging to the theme are listed below.

Table 14. Data analysis based on the competency level for the first mathematics course

Theme	Category	Code	f	%
Competency for the first maths course	Competency	Very competent	47	100
		Thanks to this course, it is possible to solve this problems in a much more accurate way	1	2,1
	Suggestions	It would be more convenient if given at the same semester as material design and origami	1	2,1

Analyzing the data relevant to determining the class level for the mathematics course, it is observed that there is consensus among students that the course is given at the right time. In addition to that, they suggested that the course could be given at the same semester with the material design and origami courses, so that they can support one another.

3.15. Analysis of the data relevant to determining the class level

Analysis of the data relevant to determining the class level and the categories and codes belonging to the theme are listed below.

Table 15. Analysis of the data relevant to determining the class level

Theme	Category	Code	f	%
Class Level	University	From the 2nd grade	14	29,7
		From the 3rd grade	12	25,5
		From the 1st grade	10	21,2
		It should be given for one semester each year	7	14,8
		It should be given at the 4th grade, so that it can be permanent	3	6,3
		For two semester at the 2nd semester	1	2,1
		It should be gradually given in four years	1	2,1
	Secondary School	It should be given at the elementary school level	3	6,3
		It should be given at the 5th and 6th grades	3	6,3
		From the elementary school 8th grade	2	4,2
		From the elementary school 7th grade	2	4,2

Analyzing the answers given to the question about why this course should be given at a certain class level, it is observed that the majority of them thinks this course should be given at the university level, even though there are also some students, who believe it should be given starting from secondary school level. Generally, the students suggested that it should be given in the first years of university education, whereas; some of the students suggested that it should be given at different class levels. Another observation is that some students believe it should be given starting from the fifth grade.

3.16. Three concepts occurring to them about problem solving

Three concepts occurring to them about problem solving and the categories and codes belonging to the theme are listed below.

Table 16. Three concepts occurring to them about problem solving

Theme	Category	Code	f	%	Category	Code	f	%
Problem çözme denince aklına gelen üç kavram	Problem solving	Strategy	24	51,0	Personal opinion	Esen teacher	2	4,2
		Problem	18	38,2		It is an effective course	1	2,1
		What is given/what is expected	10	21,2		A nice semester	1	2,1
		Understanding the problem	6	17,7		My success in the group work	1	2,1
		Solution	5	10,6		Relaxation	1	2,1
		Problem solving	5	10,6		When I had a hard time solving the problem in the first lesson	1	2,1
		Stages	5	10,6		The fact that I am not afraid of problem solving anymore	1	2,1
		Evaluation	5	10,6		Taking my problem solving skills to an advanced level	1	2,1
		Group work	5	10,6		Learning how to scrutinize a problem	1	2,1
		Diagram-connection	4	8,5		Effective solution and understanding	1	2,1
		Gradual progress	1	2,1		The fact that strategy selection is sometimes difficult	1	2,1
		Systematical thinking	1	2,1		The fact that selecting a false strategy creates chaos	1	2,1
		Implementation of the strategy	2	4,2		Going through the books to find the solution to the problem	1	2,1
		Reasoning	1	2,1		Solving the problem on the board	1	2,1
	Mathematic	Mathematics	4	8,5		Control	1	2,1
		Applied Mathematics Teaching	2	4,2		Description	1	2,1
		Different opinions	2	4,2		How I used to solve problems	1	2,1
		Logic	2	4,2		How they solved the problems for us	1	2,1
		Mathematics Curriculum	1	2,1		Did I understand the problem?	1	2,1
		Mathematical Language	1	2,1		Was I able to solve it?	1	2,1
		Equation	1	2,1		Is my solution correct?	1	2,1
						Occupation	1	2,1
						Relation	1	2,1
						There are no problem without a solution	1	2,1
						Definitely write down the given information	1	2,1

Examining the answers of the students to the question about expressing problem solving in three concepts, the categories can be listed as problem solving, mathematics, and

personal opinion. In the problem solving category, they often discussed the problem solving stages. In the mathematics category, they used expressions such as mathematical language and logic. In the personal opinion category, it is observed that they evaluated by considering how the course makes them feel emotionally.

3.17. Analysis of the data relevant to determining the level of contribution and productivity of the course

Analysis of the data relevant to determining the level of contribution and productivity of the course and codes belonging to the theme are listed below.

Table 17. Analysis of the data relevant to determining the level of contribution and productivity of the course

Theme	Category	Code	f	%
Productivity and Contribution of the Course	Positive	Very efficient	40	85,1
		I can solve problems more comfortably	36	76,5
		It enabled me to pay attention to the necessary steps	20	42,5
		I can teach my students more systematically in my internship	18	38,2
		We comprehended how an educator must solve a problem	16	34,0
		I can find what to implement	13	27,6
		Comprehending the strategies efficiently	13	27,6
		I will not have difficulty with explaining a problem to a student in my professional life	13	27,6
		I can solve problems more easily	12	25,5
		We solve problems in a more knowledgeable and conscious way	11	23,4
		It enabled me to extract new problem situations and create solutions	11	23,4
		Deciding what to do before starting with the problem	11	23,4
		I enjoyed it throughout the semester	10	21,2
		It strengthened our frienships	7	14,8
		Seeing new solutions	6	12,7
		Encountering different types of questions	8	17,0
		I do not look at problems with prejudice	4	8,5
		We learned different methods and techniques	4	8,5
		I am not concerned with understanding the problem correctly	7	14,8
		I took on another level in problem solving	3	6,3
		Making practices in the classroom made the lesson more enjoyable	3	6,3
		It made think logically	2	4,2
		Our ability to analyze and synthesize improved	1	2,1
		It is a very serious subject, which should be given for another semester, so that success will be tripled	1	2,1
		I wish we had solved more problems	1	2,1
	Negative	I did not know what to do at the beginning of the semester	7	14,8
		The theorical knowledge given at the beginning of the semester was boring	2	4,2
		The fact that the course was at afternoon decreased our productivity	1	2,1
		There were disruptions during the presentation	1	2,1

Examining the impact of the course on the student, there occurs two categories: positive views and negative views. There are positive views such as approaching problems more comfortably thanks to this course, positive contribution to their instruction of the course as well as their professional development, and learning how to proceed while

teaching students. The negative views include believing that the timing is not good and the four-week course is boring, thus their efficiency decreases. Moreover, some of the negative comments were due to the various disruptions during the presentation of the course.

4. Discussion and Conclusions

Examining the responses of the students, it is observed that they greatly enjoyed the course, learned many things, their outlook on the mathematics course changed, and got the chance to implement the problem solving stages. Moreover, they mentioned that this course will become very beneficial for them once they start teaching in various provinces and serves as a major step towards becoming a good teacher. They stated that there has been major changes in their pre-implementation and post-implementation approaches towards problems and that they now approach a problem in a more systematic and conscious manner. They stated that before the implementation, they usually solved the problems through trial and error method or the methods they had known before. Furthermore, they added that after the implementation they realized that there is a strategy for each solution and they learned how to use those strategies

[1,3,4,5,6,7,10,12,13,22,28,33,39,43,47] They stated that they had many false approaches inn the problem solving process before the implementation. These errors were found out through the content analysis in the classroom. Before the implementation, they associated problem solving with concepts such as chaos and difficulty, however, after the implementtion they started associating problem solving with strategy, solution, gradual progress, logic, information given and asked. It was stated that students' skills of solving non-routine problems were low. Examining the results of the interviews, it is observed that the students argue that the strategies they had used to approach problems were deficient and false.

[26] states that mathematical education continuously becomes less successful. He argues that this is because students do not learn how to build mathematics in their elementary school years. The interviews suggest that argument. Because students believe that they will become better teachers after this course. Because they believed they will be able to explain that to the students in a better manner. Some students mentioned that they wished they had learned this method sooner, which indicates that they associate their lack of success with not learning about this subject during their education.

[30] utters that students develop their academic self-perception as they find alternative solutions to the current and possible problems. In this study, it was observed that the more knowledge students obtained about this subject, the more their academic self-confidence increased. Most of the statements received from students supports this assertion. Their statements include expressions such as "I am not afraid of problems, because I know how to approach each problem".

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