European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

DOI: 10.46827/ejes.v8i3.3645 Volume 8 | Issue 3 | 2021

INVESTIGATION OF KNOWLEDGE OF MATHEMATICS TEACHERS ABOUT PROBABILITY PROBLEMS

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Abstract:
The probability subject and problems about this subject can cause some difficulties for teachers as well as for students. In this context, this study aims to investigate the knowledge and opinions of mathematics teachers about the subject of probability. This research was designed as a case study, which is one of the qualitative research designs. The sample of the study consisted of a total of 28 mathematics teachers, 18 of whom were females and 10 of whom were males, working in state schools in a southern city of Turkey. In addition, interviews were also conducted with a total of 8 mathematics teachers, 6 females and 2 males, among the teachers who participated in the study in order to investigate their general opinions about the subject of probability. In order to collect data, the probability problems test was used to determine the knowledge of mathematics teachers about probability problems, and a semi-structured interview form was used to investigate their general opinions on probability. The results of the research showed that the teachers' rate of determining the type of probability problems correctly was 80.6 %. It was also seen that the 37.75% of the mathematics teachers used formulas, 29.6% of them used procedural methods and 31.60% of them used graphical methods in the calculations to solve probability problems.

Keywords: probability, permutation, combination, mathematics teachers

1. Introduction

Problem solving lies at the heart of mathematical practices. Individuals need problem solving skill to understand and use mathematics (Polya, 2006). Schoenfeld (2014) defined problem solving as a concept helping students appreciate the value of mathematics, learn

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mathematical concepts, develop creative thinking skills, and practice their distinctive skills towards mathematics.

Probability problems are a specific area of mathematical problem solving. Investigating the knowledge of mathematics teachers about probability problems and their general opinions on probability were focused on in this research. Probability is verbalized as a tool that can be used to model reality by Borovcnik and Kapadia (2018), and as the mathematical equivalent of likelihood by Bluman (2005). Altun (2010) explained the concept of probability as a situation that we encounter in many situations in daily life, such as predicting whether it will rain or not by looking at the weather during the day, whether something will happen, tossing a coin or dice, and games of chance. Probability deals with unpredictable actions and their consequences (Grimmett & Welsh, 2014). Indeed, it is predicting the future (Karaçay, 2006) or uncertainty's action of estimating the chance (Baki, 2018; Kapadia & Borovcnik, 1991). The concept of probability deals with random or uncertain events and uses mathematics with its all details. It is very difficult for us to reach a decision based on the results of observations about some events realization of which depends completely on chance and the results of which we do not know in advance. We make use of the concept of probability for evaluating and specifying the uncertainty and risks of these events mathematically (Arı & Topçu, 2010). In a nutshell, it can be said that probability is the chance of an event to occur or not to occur or its likelihood.

The concept of probability was first used in the 1650s in the studies of Fermat and Pascal. In the 17th century, Gauss, De Moivre and Laplace significantly contributed to the development of the concept of probability. In the 18th and 19th centuries, the scope of application of probability expanded and probability started to gain importance in parallel with this expansion (Şenyay, 2015). After starting to be used in various business areas and daily life more and gaining importance, the subject of probability was included in the mathematics curriculum in many countries towards the end of the 19th century (Gürbüz, 2010; Kazak, 2010). Issues about the concept of probability are credited in every field: the weather forecaster predicts that it will snow with 60% probability, researchers in the field of medicine predict that people who follow a certain diet are more likely to catch a heart disease, investors calculate the risks of stocks, and lots of examples such as these are seen in daily life. The prominence of probability methods and ideas has led the subject of probability to be seen more in the school curriculum (Van de walle, 2014).

The subject of probability was included in the curriculum in the 1960s. It was emphasized by National Council of Teachers of Mathematics [NCTM] (2000) that teaching probability should be started from an early age. The acquisitions about probability were included in the 4th grade mathematics curriculum in 2009 and 2013 and they only exist in the 8th grade acquisitions in 2018 primary education mathematics curriculum, in which eighth grade students are expected to identify possible situations of an event and to determine the events with different probabilities, to investigate events with equal probabilities, and to calculate the probability of occurrence of simple events (Ministry of National Education, [MEB], 2018). In the 2018 secondary education mathematics curriculum, on the other hand, sub-learning domains of probability are

included at every grade level of secondary education (High School), especially in the ninth, tenth, eleventh and twelfth grades. Students attending these classes are expected to solve problems about various types of probability. The expectations of NCTM regarding the subject of probability in the 3th-5th grades are similar to those of MEB (2018) in the 8th grade acquisitions. Besides, the expectations about probability in the 6th-8th grades are above the expectations of the 8th grade curriculum which is practiced in our country today. The acquisitions about probability are included in mathematics curriculum of various grade levels as it is mentioned.

Various difficulties are experienced while teaching and learning the concepts related to the subject of probability. This issue is one of the primary issues that both students and teachers have difficulties during learning and teaching (Bulut, 1994; Gürbüz, 2007; Batanero & Diaz, 2012; Bulut, 2001; Brase, Martinie, and Castillo-Garsow, 2014; Greer, 2001; Greer, 2014; Gürbüz, 2006; Gürbüz, 2017; Satisfied, 2008). In a study by Boyacıoğlu, Erduran and Alkan (1996), it was revealed that 91% of the students had difficulties in understanding the subjects of possibility and permutation the most, and similarly 84% of the teachers had various difficulties in this subject. Zahner (2005) explained the reasons why problems of probability were considered as difficult in his study. He pointed out that the presentation of the subject was not made appropriately in the cognitive process and he also mentioned that problems about probability were abstract situations requiring the calculation of probability of a series of events. Bulut (1994) presented the reasons for experiencing difficulties about this concept in his study. He claimed that students try to memorize the formula rather than understand the subject; they cannot understand the question, they have a negative attitude towards the subject and there is a lack of suitable concrete teaching material. Memnun (2008) also presented the reasons for having problems in learning the concept of probability as the students' ages, insufficient prior knowledge, and their inadequacy in reasoning skills, misconceptions, negative attitudes and problems that are induced by teachers.

When the related literature was examined, it was seen that there were several studies in which the misconceptions of mathematics teachers regarding the subject of probability were discussed (Doğucu, 2013; İlgün, 2013; Öçal, 2014), pre-service mathematics teachers' processes of solving the geometric probability problems were investigated in the context of analytical thinking (Yıldız & Baltacı, 2016) and pre-service elementary mathematics teachers' knowledge about problem posing activities and probability were investigated (Yıldız & Baltacı, 2015). Moreover, there are other studies which investigated pre-service teachers' conceptual and procedural knowledge levels on probability (Ata, 2014; Shaughnessy 1977; Özen, 2013), and reviewed the methods that are used by pre-service mathematics teachers while solving problems about probability (Zahner, 2005).

Teachers come into the prominence in making students gain the acquisitions about the concepts of probability by teaching mathematics. Creating an effective teaching environment is based on the teacher's ability to take students' thinking into consideration, and this affects the teacher's decision of instruction. Effective teaching includes pedagogical content knowledge and classroom management skills of the teacher

(Demonty, Vlassis, Fagnant 2018). Teachers make a great contribution to the structuring of concepts by the classroom culture they create and the teaching methods and activities they use. In this context, it is believed that it is important to determine the knowledge of mathematics teachers about probability and their general opinions about probability with this research.

In the related literature, no studies which consider mathematics teachers' knowledge about probability problems, the way they use in determining the type of problem, the methods they use in problem solving and their general opinions all together have been found out. Therefore, this study is expected to make contributions to the literature with its findings and make recommendations for the training of mathematics teachers. In this context, this study sought answers to the following questions.

1) What are the teachers' levels of determining the types of probability problems?
2) How are the teachers' performances about probability problems?
3) What are the calculation methods that the teachers use in solving probability problems?
4) What are the general opinions of the teachers about the subject of probability?

2. Methodology

In this part, the research design, research sample, data collection tool, collecting and analyzing data were presented.

2.1 Research design

This study aimed at evaluating the status of mathematics teachers about probability problems and investigating their opinions about the subject of probability. It was designed as a case study, one of the qualitative research designs. Case study is a qualitative approach in which in-depth information about a case is gathered through multiple information resources and a description of a case is presented (Creswell, 2015, p. 97). Case studies are conducted in order to describe and see the details that generate an event, develop probable explanations about an event and evaluate an event (Gall, Borg & Gall,1996 in Büyüköztük, Çakmak, Akgün, Karadeniz and Demirel, 2017).

2.2 Participants

The research consisted of 28 mathematics teachers, 18 females and 10 males, who were selected according to the convenience sampling method and who voluntarily participated in the study. Besides, interviews were also carried out with 8 mathematics teachers totally, 6 female and 2 male, who were picked from the teachers who participated in the study voluntarily.

Gathering information about a case, which is determined as typical among many cases in the population, is needed in case sampling method (Büyüköztük, Çakmak, Akgün, Karadeniz and Demirel, 2017). The service length and gender distribution of mathematics teachers who were in the sample of the study was shown in Table 1.

Table 1: The distribution of mathematics teachers according to their duration of teaching experience and genders

Length of service	Gender		
	Female	Male	Total
	N	N	
1-5 years	3	4	7
6-10 years	4	1	5
11-15 years	11	4	15
16-20 years	-	-	-
21 years -	-	1	1
Total	18	10	28

When Table 1 was considered, 28 teachers in total participated in the study. 18 of them were female and 12 of them were men. It was also observed that approximately 23.3% of 28 teachers have 1–5 years of teaching experience, 16.7% of them had 6–10 years of teaching experience, 50% of them had 11–15 years of teaching experience and 6.7% of them had 21 years or more teaching experience.

2.3 Data collection tools

As data collection tools, the Probability Problem Test (PPT) developed by the researchers in order to evaluate the conditions of the mathematics teachers about probability problems was used together with a semi-structured interview form to determine the opinions of the teachers about the probability subject.

The probability Problem Test (PPT) consisted of 7 problems. These problems contained various types of probability problems such as permutation, combination, conditional probability, probability of the occurrence of a simple event, continuous event, independent event and dependent event. The participant teachers were asked to answer the questions of "*i. What is the type of this problem? ii. Solve the problem.*" for all the problems in the PPT.

In the semi-structured interview form, which was arranged so as to determine the general opinions of the teachers about the probability subject, there were questions of "*i. What do you think about probability problems' existing only in the eighth grade curriculum? ii. Can the students solve probability problems? Do the students have any difficulties while solving these problems? If yes, can you explain what these difficulties are? iii. Can you explain what you do to eliminate the difficulties which the students have while solving probability problems? iv. What are your recommendations about the instruction of probability subject?*"

2.4 Data collection

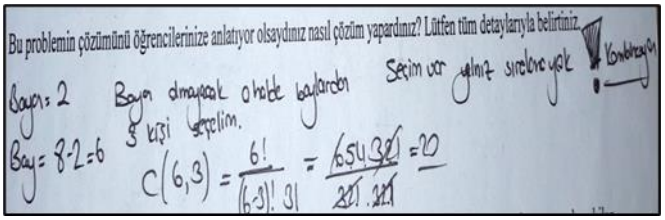
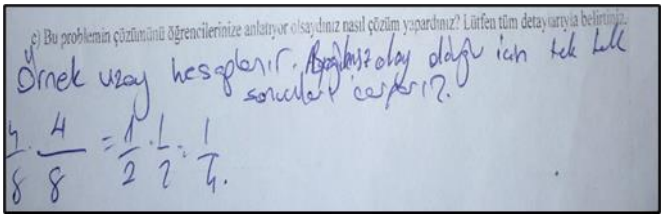
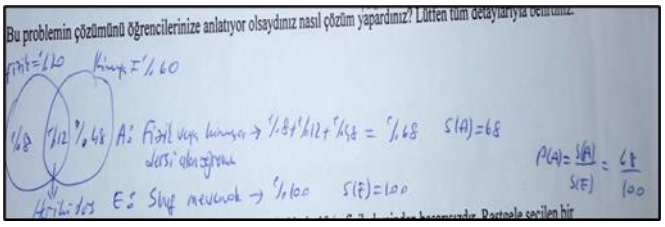
The PPT which was used to determine the teachers' knowledge about probability problems was administered to participant teachers in individual sessions. The teachers were asked to answer the questions in the test. The questions in the semi-structured interview form which was used to determine the general opinions of the teachers about the probability subject were also given to the teachers individually and their answers

were recorded with a tape recorder by the researchers after getting the consent from the teachers.

2.5 Data analysis

The answers given by the teachers to the questions in the probability test, their ways of solving the problems and the answers given by the teachers to the questions in the semi-structured interview form were analysed through qualitative analysis methods. When the problem type and the solution were correct, it was coded as "1" and when they were wrong, they were coded as "0". The calculation methods which were used in solving the probability problems were coded as formula, procedural, graphical and no solution produced. Some samples of calculation methods were given in Table 2.

Table 2: The codes, samples and explanations about the calculation methods used in solving problems

The codes of calculation methods	**Sample**	**Explanation of the codes**
Formula		The situation of using the formulas which had been learned before in solving the problem.
Procedural		The situation of not using a formula or a graphical method in solving the problem but reaching the conclusion by doing mathematical operations
Graphical		The way of emphasizing the relationships between the elements in the problem by visual components. The situation of using Venn diagram, tree diagram, chart etc. in solving the problem.

The qualitative data obtained through interviews were analysed by means of the descriptive analysis method. The data obtained from the teachers who were interviewed were transcribed and read. Then, the findings were interpreted so as to add meaning to the collected data, to explain the relationships between the findings, and to draw conclusions. In descriptive analysis, direct quotations are frequently used to reflect the opinions of the individuals who were interviewed in a conspicuous way. The purpose of

this type of analysis is to present the findings which were obtained to the reader in an organized and interpreted form. In line with this purpose, the data which were obtained are first described systematically and clearly. Then, these descriptions are explained and interpreted. Next, cause-effect relationships are dealt with and it is concluded (Yıldırım & Şimşek, 2006, 224).

3. Findings

In this part, the findings about the research problems were presented.

3.1. The findings about determining the types of probability problems

It was found out in the analysis of the findings related with the answers of the mathematics teachers about determining the types of the problems in the PPT that they reached a 5.64 average of correct answer. The distribution of frequency and percentage about determining the types of probability problems correctly in the answers of the mathematics teachers (28x7=196) was given in Table 3.

Table 3: Descriptive statistics about the teachers' determining the types of probability problems

Problem types	**F**	**%**
Continuous event	19	67,9
Conditional probability	21	75,0
Independent event	24	85,7
Permutation	21	75,0
Combination	25	89,3
Dependent	23	82,1
Probability of the occurrence of a simple event	25	89,3
Total	158	80,6

As seen in Table 3, among the answers of the teachers that the rate of their determining the continuous event problem correctly is 67.9%. It is 75.0% for conditional probability and permutation problems, 82.1% for dependent event problems, 85.7% for independent event problems, and 89.3% for the probability of the occurrence of a simple event. In addition, it is also seen in Table 3 that the rate of determining the type of problem correctly for 7 probability problems in the PPT is 80.6%. Thus, it seems that the rate of the teachers' determining the types of problems correctly in the PPT is high and it can be said that they have a moderate success in determining the types of probability problems when it is thought that these answers belong to mathematics teachers.

3.2 Findings about the performances of the mathematics teachers in probability problems

The analysis of the data obtained from the answers of the mathematics teachers about their performances in the PPT showed that the teachers reached an arithmetic mean of 6.64 in giving the correct answer. The distribution of frequency and percentage about

solving the problem correctly in the answers of the mathematics teachers (28x7=196) was given in Table 4.

Table 4: Descriptive statistics about the teachers' solving the probability problems

Problem types	**F**	**%**
Continuous event	27	96,4
Conditional probability	27	96,4
Independent event	26	92,9
Permutation	25	89,3
Combination	26	92,9
Dependent	27	96,4
Probability of the occurrence of a simple event	26	92,9
Total	184	% 93,9

As observed in Table 4, 89.3% of the teachers solved the permutation problems correctly, 92.9% of them solved the combination and the probability of the occurrence of a simple event and independent event problems correctly, and 96.4% of them solved the continuous event, conditional probability, and dependent event problems correctly. From this perspective, it can be said that the teachers who participated in this study show less success in solving permutation problems than other problems.

When the findings of the first and second research questions are put together, it is seen that the teachers are not at the desired level in determining the types of the problems, and their performance in solving the problems is good. Incorrect or imperfect knowledge of the teachers about the types of probability problems show that it is one of the reasons of complexity during the instruction. Incorrect or imperfect knowledge of the teacher does not pose an obstacle in solving the problem correctly; however, this may not be valid for the students during the instruction.

3.3 Findings about the calculation methods used in solving the probability problems

The analysis of the data obtained from the answers of the mathematics teachers about the solution of the probability problems showed that the distribution of frequency and percentage about the calculation methods used in solving the probability problems (28x7=196) as in Table 5.

It is observed in Table 5 that 37.7 % of the teachers used formulas in their solutions, 29.6% of them used procedural method without depending on formulas and diagrams, 31.6% of them used graphical calculation method. Besides, 1% of the teachers did not produce any solutions. According to the Table, all of the mathematics teachers solved the combination problem by using formula. Here are some samples of the calculation methods which the teachers used in solving the problems (Figure1, Figure 2, Figure 3).

Table 5: Descriptive statistics about the calculation methods which the teachers used in solving the probability problems

Problem Types	The method used in the solution							
	Formula		Procedural		Graphical		No solution produced	
	f	%	f	%	f	%	f	%
Continuous event	19	67,8	0	0	9	32,1	0	0
Conditional probability	1	3,6	4	14,3	22	78,6	1	3,5
Independent event	3	10,7	7	25,0	18	64,3	0	0
Permutation	10	35,7	12	42,9	6	21,4	0	0
Combination	28	100	0	0	0	0	0	0
Dependent	4	14,3	21	75,0	3	6,7	0	0
Probability of the occurrence of a simple event	9	32,1	14	50,0	4	10,7	1	3,5
Total	74	37,75	58	29,6	62	31,6	21,0	1

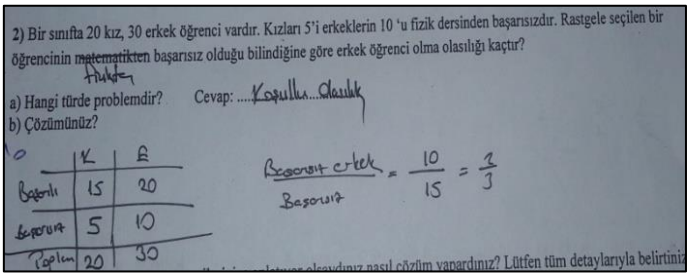


Figure 1: The solution in which graphical method was used

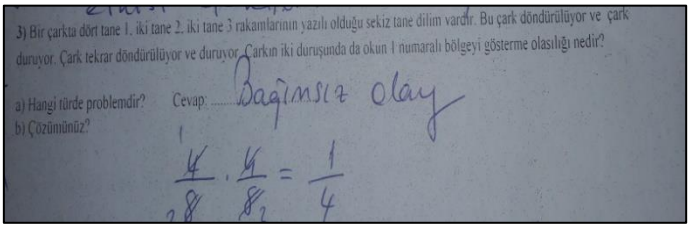


Figure 2: The solution in which procedural method was used

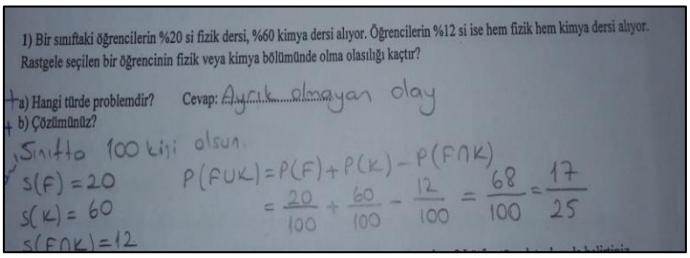


Figure 3: The solution in which a formula was used

3.4 Findings about the opinions of mathematics teachers about the probability subject

The teachers were asked the question of "What do you think about the probability problems' existing only in eighth grades (the probability of the occurrence of a simple event)?". Most of the teachers (T1, T2, T3, T4, T5, T6, T7) expressed that it was enough for the probability problems to exist in the current secondary school mathematics curriculum as it existed at the time, the probability of the occurrence of a simple event. One of the

teachers (T8) stated negative opinions about shifting the probability problems into the high school curriculum and added that all probability problems should be included in the secondary school curriculum albeit at the basic level. In addition to this, T2 stated that the probability subject improved the students' perspectives, some of the teachers (T2, T3, T4, T7) expressed that the probability subject was related with daily life and T5 told that it improved thinking skill. Some of the teachers' opinions are as follows:

> *"Probability subject is treated in a simple way in the eighth grades as the probability of the occurrence of a simple event. I can teach this subject more easily by associating it with daily life as is (T3)".*
>
> *"It is a subject which improves the students' thinking skills, it is much better to exist in the current curriculum at a basic temel. The children were not able to distinguish. I believe it would be easier to understand if it is taught after the effect of the instruction of and/or statements following the subject of logic in high school (Ö5)".*
>
> *"I think all types of probability should also be mentioned in eighth grades (Ö8)".*

The teachers were asked the questions of "Can the students solve probability problems?, Do the students have any difficulties while solving these problems?, If yes, can you explain what these difficulties are?". All of the teachers stated that the students had difficulties in solving probability problems. The teachers expressed these problems as not being able to distinguish the type of the problem (T3, T4, T5, T7, T8), the subject's being too much abstract (T1), not being able understand the logic because of solving the problems by memorizing formulas. Here are some of the teachers' opinions.

> "*The students are having difficulties. However, they were able to reach the solution when they considered some key words while teaching such as with the condition of not throwing back into the pouch in dependent event problems. No matter how much we materalize, no distinction can be made. The fact that it is at a simple level in the current curriculum has obviously made it easier for both us and our students. (T4)".*
>
> *"The students are having problems in this subject. They are having difficulties in distinguishing the type of the problem. Naturally, their solutions can be wrong because they cannot make the distinction completely. After a while, they become more inclined to memorize formulas, they do not learn its logic. And when time passes, they forget because they memorize (T3)"*

The teachers were asked the question of "Can you explain what you do to eliminate the difficulties which the students have while solving probability problems?". The teachers stated that they formed figures and taught by making the students practice in order to materialize the subject as much as possible (T1, T3, T2, T5, T8), made the students solve the same type of problems sequentially in order to provide distinguishing

(T4, T6), used keywords (T7, T5, T4) and made connections with real life (T2, T3). The opinions of some teachers are presented below.

> *"I try to involve the children into the subject by writing numbers into the pouch or making colourful papers. I explain the subject by drawing figures and charts more to materialize the subject (T3)".*

> *"I try to explain its logic. For example, I tell them that permutation is sequencing and combination is selecting. I solve plenty of examples so as to make them understand the distinction (T7)".*

> *"I try to explain the subject by using some materials in the classroom, drawing a student, a pencil or figures to materialize the subject (T8)".*

The teachers were asked the question of "What may be your recommendations about teaching the subject of probability?". Teachers said that clear examples which facilitate distinguishing should be included in the coursebooks instead of confusing examples (T3, T4), the subject should be taught by associating it with daily life (T3, T4), materials for every subject should be prepared (T1) and instruction should be supported visually by various videos (T5, T7). In addition, some teachers stated that in-class practices should be included (T5, T7), the teachers should do some preparations before the class (T5, T8) and the teachers should stay up-to-date in terms of technology (T6). The opinions of some teachers are as follows.

> *"The subject may become more visual and permanent with various video explanations. Materials may be designed. Marbles and a pouch can be brought to class to make practices (T7)".*

> *"Teachers should renew themselves and should be open to innovations in terms of using the technology effectively (T6)".*

> *"Examples in which distinguishing is made clearly should be included in the coursebooks and test books. Incorrect examples and confusing situations should be whittled down. Moreover, the subjects should be associated with daily life (T4)".*

4. Discussion

This study aiming to evaluate the states of mathematics teachers about probability problems and investigate their general opinions about probability is based on the findings obtained from 28 mathematics teachers. When the levels of the teachers in determining the types of probability problems are considered in line with the research questions, it is seen that the rate of determining the problem type correctly for a total of 7 probability problems in PPT is 80.6%. Although it seems like a high level of success, it

can be said that this rate is at a medium level indeed when it is considered that mathematics teachers are the ones who teach the concept of probability. This finding presents that the concepts and problems about probability subject cannot be completely distinguished by the teachers as well as by the students. In this study, the answers of the mathematics teachers showed that the rate of determining the continuous event problems correctly was 67.9%, the rate of determining conditional probability and permutation problems was 75.0%, the rate of determining dependent event problems was 82.1%, the rate of determining was 85.7% for independent event problems, the rate of determining combination problems and probability of the occurrence of a simple event problems was 89.3%. It was observed that teachers were having difficulties in distinguishing the types of problems. Similarly, Dereli (2009) concluded in his study with eighth-grade students that the students, who were mistaken in explaining dependent and independent events, were also mistaken in their calculations of probability. Besides, he also found out that the students who experienced misconception about permutation and combination gave the answer of permutation to the questions in which selecting was important and the answer of combination to the questions in which sequencing was important. Tunç (2006) conducted a study in which he evaluated the level of teaching knowledge and skills about probability to the eighth-grade students and revealed that independent event problems, dependent event problems, abstract event problems and continuous event problems are confused with each other. In a similar study by O'Connell (1999), the mistakes of 50 students graduated from the faculty of education pr psychology of New York Kent University in solving probability problems were discussed and it was concluded that the students expressed the situation wrongly in calculating the probability in dependent and independent event problems. It is an important finding that teachers have difficulties in distinguishing the problems as well as students. In addition, it is an important reason to distinguish the type of problem in order to solve problems correctly.

In line with the second research question of this study, it was seen that the teachers the correct answer average was 6.64 according to the analysis of the data obtained from the answers of mathematics teachers about their performance in PPT. It can be said that the correct answer average is high. However, it is expected from them to solve the problems easily when it is considered that they are mathematics teachers. Furthermore, it was observed that the most difficult problem type in PPT is the permutation problem. It can be said that this is due to the fact that the permutation and combination problem types cannot be distinguished from each other. In the related literature, the studies which were conducted by Bulut, 1994; Gürbüz 2007; Boyacıoğlu, Erduran & Alkan 1996 reported that pre-service mathematics teachers generally had difficulties regarding the concept of probability as well as students. 84% of teachers expressed that the concept of probability is the leading subject among the ones in which they were having difficulties. In line with the third research question of this study, the calculation methods which the mathematics teachers used in solving probability problems were investigated. It was seen that 37.75% of them used formulas, 29.6% of them used procedural method and 31.60% of them used graphical method. Besides, it was also found in this study that the problem type in which formula was used the most was combination problems (100%), the problem

type in which procedural method was used the most was dependent event problems (75%) and the problem type in which graphical method was used the most was conditional probability problems (78.6%). Zahner (2005) concluded in his study with pre-service mathematics teachers that they used procedural method, formulas and graphical methods, respectively in solving the probability problems. Moreover, he found out that the problem type in which formula calculation method was used the most was combination problems, the problem type in which procedural method was used the most was independent events problems and the problem type in which graphical method was used the most was the problems containing basic principles. In this context, it can be said that the findings about the calculation methods which are used show similarities.

In line with the fourth research question of this study, the teachers were asked about their opinions on the presence of probability problems in the curriculum. The majority of the teachers stated that including the probability of a simple event at the level as it was in the current secondary school mathematics curriculum was sufficient and appropriate. It was observed that students had difficulties about probability problems and these difficulties were mostly because of not being able to distinguish the problem types. The teachers stated that they introduced the subject by materializing it as much as possible and they solved plenty of questions from the same type of problems in order to overcome these difficulties. The teachers made some recommendations about teaching this subject that examples with clear distinctions should be included in the textbooks, teaching should be supported with concrete materials and visuals, and teachers should be open to renewing themselves about the use of technology. Arı and Topçu (2010) investigated the problems which are experienced in the teaching of statistics and probability in the sixth, seventh and eighth grades. They concluded that inaccurate and insufficient information in the coursebooks of mathematics might make the subjects in the coursebooks, and especially the subject of statistics and probability in which they already have difficulty in understanding, more difficult to learn and might cause mislearning. Besides, it is a fact that instruction of the subject of statistics and probability will be affected positively if the teachers include especially figures and graphics, use appropriate materials to the presentation of the subject and explain the subject in association with daily life while teaching statistics and probability issues in the mathematics course. Thus, it can be said that it shows similarities with the result of this research.

5. Conclusion and Recommendations

This study, which aims to investigate the knowledge of mathematics teachers about probability problems and their general opinions on probability, is limited by the findings that are obtained from 28 mathematics teachers. It was concluded in this study that 80.6% of the teachers were able to determine the types of probability problems correctly, but they also had difficulty in distinguishing the types of problems, and the arithmetic mean of the correct answers to 7 probability problems was 6.64. Furthermore, when the calculation methods used by mathematics teachers in solving probability problems were

considered in this study, it was seen that formulas (37.75%) and procedural method (29.6%) and graphical method (31.60%) were used while solving the problems. In this study, a single problem was used for each problem type. The study can be repeated by using more than one problem for each type with more samples.

Majority of the teachers claimed that it is sufficient and appropriate to mention the probability of the occurrence of a simple event in the secondary school mathematics program at the existing level in the current curriculum. It was observed that students had difficulties about probability problems and these difficulties were mostly not being able to distinguish the types of problems. In order to overcome these difficulties, the teachers expressed that they were teaching the subject by materializing it as much as possible and they were solving plenty of questions from the same problem type to ensure distinguishing. The teachers recommended that examples with clear distinctions should be included in the textbooks, teaching should be supported by concrete materials and visuals, and teachers should be open to renewing themselves about the use of technology. In line with this, in-service training activities can be organized for teachers by determining the subjects that are considered to be difficult to teach. Teachers with different experiences can come together and exchange views and ideas in order to support teaching, and contribute to their development in this regard.

Conflict of Interest Statement

The authors declare no conflicts of interests.

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References

Arı, E., Topçu, B. (2010). İlköğretim 6-7 ve 8. Sınıflarda Matematik dersinin istatistik ve olasılık konusunun öğreniminde yaşanan problemler ve çözüm önerileri. Yüksek Linsans Tezi, Afyon Kocatepe Üniversitesi, Afyon.

Ata, A. (2014). Öğretmen adaylarının olasılık konusuna ilişkin kavramsal ve işlemsel bilgi düzeylerinin incelenmesi. Master'sthesis, ESOGÜ, Eğitim Bilimleri Enstitüsü

Batanero, C., & Díaz, C. A. R. M. E. N. (2012). Training school teachers to teach probability: reflections and challenges. Chilean Journal of Statistics, 3(1), 3-13.

Bluman, A. G. (2005). Probability demystified (pp. 1-77). McGraw-Hill.

Borovcnik, M., & Kapadia, R. (2018). Reasoning with risk: Teaching probability and risk as twin concepts. In Teaching and Learning Stochastics (pp. 3-22). Springer, Cham.

Borovcnik, M., Bentz, H. J., & Kapadia, R. (1991). A probabilistic perspective. In Chance encounters: Probability in education (pp. 27-71). Springer, Dordrecht.

Boyacıoğlu, H., Erduran, A. & Alkan, H. (1996). Permütasyon, kombinasyon ve olasılık öğretiminde rastlanan güçlüklerin giderilmesi. II. Ulusal Eğitim Sempozyumu, Marmara Üniversitesi, Atatürk Eğitim Fakültesi, İstanbul.

Brase, G. L., Martinie, S., & Castillo-Garsow, C. (2014). Intuitive conceptions of probability and the development of basic math skills. In Probabilistic Thinking (pp. 161-194). Springer, Dordrecht.

Bulut, S. (1994), The effects of different teaching methods and gender on probability achievement and attitudes towards probability. Yayımlanmamış Doktora Tezi, Orta Doğu Teknik Üniversitesi, Ankara.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2017). Bilimsel araştırma yöntemleri. Pegem Atıf İndeksi, 1-360.

Creswell, J. W. (2015). Nitel Araştırma Yöntemleri (2. baskı). Ankara: Siyasal Kitabevi

Demonty, I., Vlassis, J., & Fagnant, A. (2018). Algebraic thinking, pattern activities and knowledge for teaching at the transition between primary and secondary school. Educational Studies in Mathematics, 99(1), 1-19.

Dereli, A. (2009). Sekizinci sınıf öğrencilerinin olasılık konusundaki hataları ve kavram yanılgıları. Yayımlanmamış Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi Fen Bilimleri Enstitüsü, Eskişehir.

Doğucu, M. (2013). The relationship between mathematics teachers' probability approaches and misconceptions. Boğaziçi University, Graduate Program in Secondary School Science and Mathematics Education, İstanbul.

Greer, B. (2001). Understanding probabilistic thinking: The legacy of Efraim Fischbein. Educational Studies in Mathematics, 45, 15-33.

Greer, B. (2014). Commentary on perspective II: Psychology. In Probabilistic Thinking (pp. 299-309). Springer, Dordrecht.

Grimmett, G., & Welsh, D. (2014). Probability: an introduction. Oxford University Press.

Gürbüz, R. (2007). Olasılık konusunda geliştirilen materyallere dayalı öğretime ilişkin öğretmen ve öğrenci görüşleri, Kastamonu Eğitim Dergisi,15, 259-270.

Gürbüz, R. (2010). Etkinlik temelli öğretimin olasılık yedinci sınıf öğrencilerinin kavramsal gelişimine etkisi. International Journal of Mathematical Education in Science and Technology, 41 (6), 743-767.

İlgün, M. (2013). An investigation of prospective elementary mathematics teachers' probabilistic misconceptions and reasons underlying these misconceptions. Doctoral dissertation, Middle East Technical University.

Karaçay, T. (2006). Olasılığın Matematiksel Temelleri. İstanbul Kültür Üniversitesi Yayınları Yayın No, 1.

Kazak, S. (2008). Öğrencilerin olasılık konularındaki kavram yanılgıları ve öğrenme zorlukları. Matematiksel kavram yanılgıları ve çözüm önerileri, 121-150.

MEB (2018). İlköğretim Matematik Dersi 5–8 Öğretim Programı. Talim Terbiye Kurulu Başkanlığı, Ankara

Memnun, D. S. (2008). Olasılık kavramlarının öğrenilmesinde karşılaşılan zorluklar, bu kavramların öğrenilememe nedenleri ve çözüm önerileri. İnönü Üniversitesi Eğitim Fakültesi Dergisi, 9(15), 89-101.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. Reston, VA: NCTM.

O'Connell, A. A. (1999). Understanding the nature of errors in probability problem-solving. Educational Research and Evaluation, 5(1), 1-21.

Öçal, M. F. (2014). Students' intuitively-based misconceptions in probability: Teachers' 127 awareness and teaching practices in middle and high schools. Doktora Tezi, Ortadoğu Teknik Üniversitesi, Ankara

Özen, M. (2013). Investigation of pre-service mathematics teachers‟ critical thinking processes through statistical and probabilistic knowledge in the context of popular media texts Yüksek Lisans Tezi, Ortadoğu Teknik Üniversitesi, Ankara

Polya, G. (1957). Nasıl Çözmeli? Çev. Feryal Halatçı, İstanbul: Sistem Yayıncılık.

Schoenfeld, A. H. (2014). Mathematical problem solving. Elsevier.

Şenyay, L. (2015). Olasılık. Online: http://kisi.deu.edu.tr//levent.senyay/istatistikI_2015_2016/5%20olas%C4%B1l%C4%B1k.pdf.

Shaughnessy, J. M. (1977). Olasılık yanılgıları: Üniversite düzeyinde olasılığa giriş için küçük grup, faaliyet tabanlı, model oluşturma yaklaşımı ile bir deney. Matematikte Eğitim Çalışmaları, 8 (3), 295-316.

Tunç, E. (2006). Özel ilköğretim okulları ile devlet okullarının 8. sınıf öğrencilerine olasılık konusundaki bilgi ve becerileri kazandırma düzeylerinin değerlendirilmesi. Master's thesis, Balikesir Üniversitesi Fen Bilimleri Enstitüsü.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. W. (2014). İlkokul ve ortaokul matematiği gelişimsel yaklaşımla öğretim (7. Baskı). Çev. S. Durmuş). Ankara: Nobel Yayınları.

Yıldırım, A., & Şimşek, H. (2006). Sosyal bilimlerde nitel araştırma yöntemleri. Seçkin Yayıncılık.

Yildiz, A., & Baltaci, S. (2015). İlköğretim Matematik Öğretmen Adaylarının Problem Kurma Etkinlikleri ile Olasılığa Yönelik Bilgilerinin İncelenmesi. Journal of Kirsehir Education Faculty, 16(1).

Yildiz, A., & Baltaci, S. (2016). Reflections from the Analytic Geometry Courses Based on Contextual Teaching and Learning through GeoGebra Software. Online Submission, 6(4), 155-166.

Zahner, D. (2005). Clinical interviewing and problem-solving protocols to uncover the cognitive processes of probability problem solvers. Doctoral dissertation, Columbia University, Dissertation Abstracts International, 66, 2851.