# FACTORS AFFECTING PRESERVICE MATHEMATICS TEACHERS' DECISIONS ON PROBABILITY TEACHING

**A THESIS SUBMITTED TO**
**THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES**
**OF**
**MIDDLE EAST TECHNICAL UNIVERSITY**

**BY**

**EMEL ÖZAYTABAK**

**IN PARTIAL FULFILLMENT OF REQUIREMENTS**
**FOR**
**THE DEGREE OF MASTER FOR SCIENCE**
**IN**
**SECONDARY SCIENCE AND MATHEMATICS EDUCATION**

**AUGUST 2004**

Approval of the Graduate School of Natural and Applied Sciences

Prof. Dr. Canan ÖZGEN
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science

Prof. Dr. Ömer GEBAN
Head of Department

This is to certify that e have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science

Assoc. Prof. Dr. Safure BULUT

Examining Committee Members

Prof. Dr. Ömer GEBAN (METU,SSME)

Assoc. Prof. Dr. Safure BULUT (METU,SSME)

Assoc. Prof. Dr. Ahmet ARIKAN(GAZİ U.,SSME)

Assist.Prof. Dr. Cennet Engin DEMİR(METU,EDS)

Dr. Hasan KARAASLAN (METU,SSME)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by this rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Emel Özaytabak
Signature :

# ABSTRACT

## FACTORS AFFECTING PRESERVICES MATHEMATICS TEACHERS' DECISIONS ON PROBABILITY TEACHING



ÖZAYTABAK, Emel

M. S. Department of Secondary Science and Mathematics Education

Supervisor: Assoc.Prof. Dr. Safure BULUT



August 2004, 83 pages



The purpose of this study was to examine the factors affecting preservice mathematics teachers' decisions on probability teaching.

The sample of the study was 248 preservice mathematics teachers from Gazi University, Hacettepe University, and Middle East Technical University. According to the gender the number of females and males were 170 and 78 respectively.

To obtain necessary data for the study, the following measuring instruments were used: (1) Probability Achievement Test (PAT); (2) Probability Misconception Test (PMT); (3) Attitude toward Probability Teaching Scale (APTS); (4) Attitude toward Probability Scale (APS). Only the third measuring instrument was developed and its reliability and validity was tested by the researcher. An interview was done with 12 preservice mathematics teachers from Gazi University, Hacettepe University, and Middle East Technical University.

The data of the study were analyzed by using SPSS and with qualitative techniques.

The results of the study demonstrated that there are some factors affecting preservice mathematics teachers' decisions on probability teaching. These factors were their attitude toward probability, probability achievement and misconceptions. Subjects thought that gender would have no affect on their decision on probability teaching.

KEYWORDS: Preservice Mathematics Teachers, Probability, Misconception, Gender, Attitude, Teaching

# ÖZ

## MATEMATİK ÖĞRETMEN ADAYLARININ OLASILIK ÖĞRETİMİ İLE İLGİLİ DÜŞÜNCELERİNİ ETKİLEYEN FAKTÖRLER

ÖZAYTABAK, Emel
Yüksek Lisans Tezi, Matematik Eğitimi Anabilim Dalı

Tez Yöneticisi: Doç. Dr. Safure BULUT

Ağustos 2004, 83 sayfa

Bu çalışmanın amacı matematik öğretmen adaylarının olasılık öğretimi hakkındaki düşüncelerini etkileyen faktörleri incelemektir. Çalışmanın örneklemi Gazi Üniversitesi, Hacettepe Üniversitesi ve Orta Doğu Teknik Üniversitesindeki 248 hizmet öncesi matematik öğretmenidir. Cinsiyete göre kız ve erkek sayıları sırasıyla 170 ve 78 dir.

Gerekli verileri toplamak amacıyla şu veri toplama araçları kullanılmıştır: (1) Olasılık Başarı Testi; (2) Olasılık Kavram Yanılgısı Testi; (3) Olasılık Öğretimine Yönelik Tutum Ölçeği; (4) Olasılık Konusuna Yönelik Tutum Ölçeği. Üçüncü ölçme aracı araştırmacı tarafından geliştirilip, geçerlilik ve güvenilirlik çalışması yapılmıştır. Gazi Üniversitesi, Hacettepe Üniversitesi ve Orta Doğu Teknik Üniversitesinden 12 öğrenci ile görüşme yapılmıştır.

Çalışmanın verileri SPSS ve niteliksel analiz teknikleri kullanılarak yapılmıştır.

Bu çalışmanın sonuçları şunları göstermektedir: Matematik öğretmen adaylarının olasılık öğretimini etkileyen bazı faktörler vardır. Bu faktörler olasılığa karşı tutumları ,olasılık başarıları, kavram yanılgılarıdır. Katılımcılar, cinsiyetin olasılık öğretimi hakkındaki düşüncelerine bir etkisi olduğunu düşünmemektedirler.

Anahtar Kelimeler: Matematik Öğretmen Adayı, Olasılık, Kavram Yanılgısı, Cinsiyet, Tutum, Öğretim

**ACKNOWLEDGMENTS**

I would like to thank to Assoc. Prof. Dr. Safure BULUT for her warm support, guidance, and suggestions during the study.

I am grateful to my parents who have provided me love, support, and educational background. And to my lovely husband and my little son Ahmet Namık. Thank you very much for your patience, moral support, and help.

**TABLE OF CONTENTS**

## LIST OF TABLES

## LIST OF ABBREVIATIONS

APS.........................................: Attitude towards Probability Scale

APTS.........................................: Attitude towards Probability Teaching Scale

C................................................: Correct

F.................................................: False

I..................................................: Incorrect

M................................................: Misconception

n.................................................: Number of cases

NA..............................................: no answer

OA..............................................: own answer

PA..............................................: Probability Achievement

PAT............................................: Probability Achievement Test

PL...............................................: Probability learning

PMT...........................................: Probability Misconception Test

w.r.t............................................: with respect to

# CHAPTER 1

# INTRODUCTION

As increased use of technology and the empirical sciences spread throughout the global community, the use of data and graphs to communicate information was ever increasing. Statistics and projected outcomes based on estimated probabilities increasingly influenced daily decision making and discussions of social issues. Unfortunately, most high school graduates had little or no background in mathematics associated with calculating probabilities and interpreting statistics. Therefore, schools needed to provide greater attention to probability and statistics in mathematics and other courses in order for our students to be adequately prepared to make informed decisions (Lee, 1999).

In past two decades, several influential organizations, including National Council of Supervisors of Mathematics in 1978, NACOME in 1975, and UNESCO in 1972, and CEEB in 1959, and the Cambridge Conference on School Mathematics in 1963 had acknowledged the role that probability and statistics play in our society (Hope & Kelly, 1983).

In recent recommendations the importance of having all students develop an awareness of probability concepts and applications had been recognized (NCTM, 1989). Numerous educators recommended the introduction concepts related to probability and statistics throughout the school years for all students, not just those students bound for college (NCTM, 1989; NRC, 1989; Shaughnessy, 1992; Lee, 1999).

In spite of increased support for teaching probability and statistics in schools, significant problems were reported in teaching and learning probability.

- Absence of probability and statistics lessons or courses in schools (Barnett, 1988; Shaughnessy, 1992): To date, very little probability and statistics had been taught in schools.
- Teachers were not prepared to teach probability. Historically, teacher preparation programs had not systematically included probability for preservice mathematics teachers (Shaughnessy, 1992).
- Students' misconceptions and understanding. Conditional probability and the notion of independent events were as particularly difficult concepts for students to grasp (Falk, 1988).
- Students' beliefs and attitudes. Statistics courses were some of the most rigorous and anxiety evoking for college students. Because of this, researchers had investigated techniques that might help to reduce anxiety and change negative attitudes experienced by students taking such courses (Sgoutas-Emch & Johnson, 1998).
- Students had difficulty in interpreting the problems (Carpenter et al., 1981; Mosteller, 1967).
- There was a conflict between probability ideas and students' experiences and how they viewed the world (Hope & Kelly, 1983).

The ideas behind probability were difficult to learn and hard to teach. Among mathematics topics, probability concepts were basically indirect and theoretical and teachers needed some particular experience to teach students (Ersoy & Bulut, 1993). Some research studies confirmed the fact that probabilistic beliefs and conceptions are difficult to change (delMas & Bart, 1987; Konold, 1983). There are several studies about probabilistic thinking of students. But there were not many investigations about probabilistic thinking of preservice teachers. In the introduction of educational changes it constantly turned out that the teacher was the central factor in the failure or success of the innovation, in general. Usually teacher decided whether or not he or she would give emphasis to the new topics in the current curricula and spent some afford how to teach them (Ersoy & Bulut, 1993).

The purpose of this study was to investigate the factors affecting preservice mathematics teachers' decisions on probability teaching.

In the present study we examined attitudes of preservice mathematics teachers toward probability learning, achievement of preservice mathematics teachers on probability, misconceptions of preservice mathematics teachers on probability and effect of gender of preservice mathematics teachers toward probability teaching.

Understanding the factors affecting preservice mathematics teachers' decisions on probability teaching would be helpful to overcome the difficulties in teaching probability to students. And it would be helpful to find the answers to such questions: "As researchers, what could we do to change and influence their conceptions and attitudes? And how could we manage to do this?"

# CHAPTER 2

# REVIEW OF RELATED LITERATURE

In this chapter theoretical bases of the present study would explained, and related studies done would be reviewed. Development of probabilistic thinking, probabilistic thinking, probability teaching and preservice teachers, difficulties in teaching/ learning probability, misconceptions and gender differences in mathematics were presented in this chapter.

## 2.1 Probabilistic Thinking

In the present study, the term "*Probabilistic Thinking"* was used to describe children's' thinking in response to any probability situation. In particular, researchers advocated the use of a general instructional model in which research-based knowledge of students' thinking was used to inform classroom instruction (Jones, Langrall, Thornton, & Mogill, 1999).

There had been considerable research into students' probabilistic thinking (e.g., Fischbein, Nello, & Marino, 1991; Fischbein & Schnarch, 1997; Jones, Langrall, Thornton, & Mogill, 1997; Piaget & Inhelder, 1951/1975; Shaughnessy, 1992). Various studies had been published concerning the developmental aspects of probabilistic thinking, starting especially with the book of Piaget and Inhelder: La Genèse de l'Idèe de Hasard chez l'Enfant (1951).

Also Fischbein (1975); Hawkins and Kapadia (1984); Garfield and Ahlgren (1988) and Shaughnessy (1992) were the studies done about the developmental aspects of probabilistic intuitions. As for misconceptions in statistical and probabilistic reasoning the main work was edited by Kahneman, Slovic and Tversky (1982).

Two main types of studies were reported in the research literature. The first type described how people thought; the second type was concerned with influencing how people thought. The first type investigated primitive conceptions or intuitions of probability and statistics, misconceptions, fallacies in thinking, judgmental biases, and so forth, the second type was concerned with influencing beliefs or conceptions, even changing them if possible. It was true that the first type had been carried out primarily by psychologists, and the second type primarily by mathematics educators. Mathematics educators discovered they had to become familiar with students' preexisting stochastic conceptions before they tried to teach the mathematical conceptions of probability and statistics (Shaugnessy, 1992).

The ideas of Shaugnessy were supported by Resnick. Resnick (1983) encouraged collaboration between cognitive psychologists and discipline specialists to improve precollege instruction in mathematics and science.

Also Garfield and Ahlgren(1988a,1988b) suggested that cooperative research endeavors between psychologists and mathematics educators would accomplish research goals much more effectively than isolated efforts that we had seen so far in stochastic. The work of Scholz and Bentrup (1984) was an example of cooperative research efforts between psychologists and mathematics educators that we needed to encourage.

Apart from these kinds of studies, Jones, Langrall, Thornton and Mogill (1997) stated in their study that for young children to exhibit probabilistic thinking there was a need for them to understand probability concepts which were multifaceted and developed over time. In order to capture the manifold nature of probabilistic thinking, their framework incorporated four key constructs. Three of these –sample space, probability of an event, and probability comparisons- had been investigated by several researchers. Few studies on the fourth construct, conditional probability, had been directed to young children, although interpretations had been drawn from data involving conditional probability.

One technique used in assessment of children's understanding of probability was to present a subject, two urns containing different proportions of balls of two colors and to ask which urn would be better to choose if one wanted to draw out at random a ball of a specified color. This technique was used by Piaget and Inhelder (1951), Siegler (1981), Green (1982) and Singer and Resnick (1992). Others, such as Hoeman and Ross (1972), did similar work involving the comparison of sectors of spinners. It had been argued by some researchers (e.g., Fischbein, 1975) that in such experiments children might be making perceptual rather than probabilistic judgments.

In recent recommendations, the importance of having all students developed an awareness of probability concepts and applications had been recognized (NCTM, 1989). Because of this emphasis on probability in school curriculum, there was a need for further, ongoing research into learning and teaching of probability (Shaughnessy, 1992). The movement toward curriculum reforms in school mathematics (Department of Education and Science and the Welsh Office, 1991; NCTM, 1989) brought a renewed emphasis on broadening the scope of the elementary mathematics curriculum. In all cases, this broadened perspective of curriculum generally adopted the position that young children need to explore the processes of probability (Department of Education and Science and the Welsh Office, 1991; NCTM, 1989). There was a growing movement to introduce elements of statistics and probability into secondary and even elementary school curriculum, as a part of basic literacy in mathematics (Garfield & Ahlgren, 1988). It was understood that the future for research in stochastic looked very bright.

Conflicting claims had been made both about people's understanding of basic probabilistic and statistical concepts and about the ease with which these concepts could be learned. A large body of research indicated that people employed a small set of heuristics when making probability judgments (e.g., Tversky & Kahneman, 1974; Shaughnassy, 1992). These heuristics often resulted in quick and generally reasonable judgments that were strongly at odds with probability theory (Konold, Pollotsek, Well, Lahmeier, & Lipson, 1993). Additionally, research by Konold (1989) suggested that some college undergraduates reasoned about uncertain outcomes using a fundamentally nonprobabilistic "outcome approach". In contrast to these findings were claims of Piaget and Inhelder (1975) that by the age of 12, most children acquired basic probability concepts even without formal instruction (Konold, Pollatsek, Well, Lohmeier, & Libson, 1993).

Briefly, Piaget claimed that the development of probability occured in three stages. In the first stage, generally characteristic of children under 7 years of age, the child was unable to distinguish between necessary events and possible events. There was no evidence for a concept of uncertainty. According to Piaget, children at this age would try to find order in a random mixture. In the second stage, up to 14 years, the child recognized the distinction between necessary and possible events, but had no systematic approach to generating a list of possibilities. A child at this stage supposedly did not possess the combinatorial skills or mathematical maturity to make an abstract model of a probability experiment. In the third stage, over age 14, the child began to develop facility with combinatorial analyses, and understood probability as the limit of a relative frequency. Thus, the concept of ratio would appear crucial to the development of the probability concept from Piaget's point of view (Shaugnessy, 1992).

Like Piaget, Green studied with young adolescents between 11-16. His study had been the largest study yet undertaken to investigate young adolescent's concepts of probability. Green(1979, 1983a, 1983b, 1987, 1988) surveyed over 3,000 students in England, age 11-16 to determine their level of Piagetion development and to find out what they knew about probability concepts and the language of uncertainty. Green found that most students had not attained the stage of formal operations by their 16th year.

Also Carpenter, Corbitt, Kepner, Lindquist, and Reys (1981) studied on relation between age and development of probability. They reported that students seem to have some intuitive notions of probabilities in very elementary situations, and that those notions grow with age.

Beside age factor on development of probability, instruction had an important role on children's development of probability. Fischbein and Gazit (1984) looked at the effects that teaching 12 lessons about probability and relative frequency had on both children's conceptions and intuitions. Fischbein believed that instruction could improve students' intuitive ideas of probability (Shaughnessy, 1992). Carpenter and his colleagues (1981) stated that students have some intuitions but they did not know how to report probability. They had difficulty in developing an intuition about fundamental ideas of probability even after instruction (Shaughnessy, 1977).

## 2.2. Probability Teaching and Preservice Teachers

It was not surprising that much of what was researched in mathematics education was driven by what was taught in schools, or by what a document recommended that we should be teaching. (See An Agenda for Action, MCTM, 1980, for example). Since very little probability or statistics had been systematically taught in our schools in the past, there had been little impetus to carry out research on problems that students had in learning it (Shaughnessy, 1992).

Meaningful mathematical content and a positive attitude toward the subject were critical attributes for educators charged with teaching mathematics to children. (Isenberg &Altizer-Tuning, 1984; Kerr & Lester, 1982). But most of the courses in probability and statistics that were offered at the university level continue to be either rule-bound, recipe-type courses for calculating statistics, or overly mathematized introductions to statistical probability that were the norm a decade ago (Shaughnessy, 1977). Thus college level students, with their prior beliefs and conceptual misunderstandings about stochastic rarely got the opportunity to improve their statistical intuition or to see the applicability of the subject as undergraduates (Shaughnesssy, 1992).

Garfield (1988) cited four issues that hinder the effective teaching of stochastic: a) the role of probability and statistics in the curriculum, b) links between research and instruction, c) the preparation of mathematics teachers and d) the way learning is currently being assessed. The teaching and learning stochastic involved building models of physical phenomena, development and use of strategies, and comparison and evaluation of several different approaches to problems in order to monitor possible misconceptions or misrepresentations. In addition, teachers' backgrounds were weak or nonexistent in stochastics. Our teacher preparation programs had not systematically included stochastics for preservice mathematics teachers (Shaughessy, 1992).

Shaughnessy (1992) stated that the real barriers for improvement of stochastics teaching were fundamentally a) getting stochastics into the mainstream of mathematical science school curricula at all, b) enhancing teachers' background and conceptions of probability and statistics, and c) comforting students' and teachers' beliefs about probability and statistics.

In their study, Begg and Edwards found that teachers seemed to have weakly developed concepts of probability and showed a reliance on prior beliefs. They preferred the questions to do with everyday life. They tended to see things in terms of representative heuristic. With randomness, they looked for spread across a range of variables and did not seem to believe that order or patterns were likely to be associated with random events.

In addition to Beggs and Edwards, in the study of Koirola, it was stated that even though some preservice teachers attempted to solve problems using their formal knowledge they ultimately relied on their everyday experiences whenever they were confused with their formal knowledge. Many of the preservice teachers in her study could not do the probability calculation formally because their probability learning was not conceptual enough to apply to everyday problems. Moreover, they forgot the mathematical rules and theorems from their probability courses. Probability at university and probability in everyday life were two different phenomena with only a small overlap. Her study also suggested that students' problem-solving strategies depended on the kinds of contexts in which problems were posed.

Today mathematicians, statisticians, and educators had different views about the teaching and learning of the probability in schools and universities. These differing views, especially the views held by preservice and in-service teachers, would have an important role on how teachers delivered their teaching in schools. (Thompson, 1992), since the classroom teacher was the pivot of mathematical education and served as the change agent in the teaching/learning process of mathematics. As Lortie (1975) reminded us, teachers taught the way they were taught and as Cuban (1993) found chancing that was hard.

Are there optimum teaching and learning techniques which take account of the child's conceptions of probabilistic notions while developing his understanding of the formal knowledge of probability? (Hawkins & Kapadia, 1984). Is there a right way to teach probability?

Fichbein (1987) believed that instruction could improve students' intuitive ideas of probability and made a distinction between primary and secondary intuitions.

Primary were the ideas and believes that we had before instructional intervention and secondary were reconstructed cognitive beliefs that we accepted and used as a result of instruction or experience.

Before Fichbein, Beyth- Maram and Denkel (1983) developed a curriculum to improve probabilistic thinking, which they used with junior high students. They found that teaching students to examine their thought processes and common modes of thinking that may cause fallacies resulted in better performance on the questionnaire used for evaluation. Pfannkuch and Brawn (1996) used activities to challenge students' intuitions and attempt to increase understanding of variation and probability with some success.

In their study, Barz (1970) and Shaughnessy (1977) found evidence that a practical involvement approach to students learning probability tended to result in higher student achievement then a traditional set-theoretic approach to probability. In Shaughnessy's study of how to present probability in a way that would increase student learning, he showed that students' misconceptions could be addressed through instruction. This was accomplished through hands-on experiments and activities in which students discovered counting principles and other concepts for themselves. Many researchers agreed that students must be active rather than passive learners and should work on meaningful projects to answer questions of interest to them (Cobb, 1991; 1993; Hogg, 1992; Roberts, 1982; Scheaffer, 1992; Snell, 1992; 1994). Newer approaches suggested an active learning format where students first made predictions about the chance of occurrence for different outcomes, then did experiments with random devices such as spinners, dice and coins, recorded their results and compare the experimental probabilities generated to their original predictions. Indeed, several researchers had recommended this method as a way to encourage students to confront and correct their misconceptions about chance events (e.g. Batanero, Serrano & Garfield; Godino et al, 1987; delMas & Bart, 1989; Shaughnessy, 1992). Since students had misconceptions and had incorrect views about probability and randomness, Garfield (1995) suggested that effective teaching be based on the knowledge of students' preconceptions. Garfield also stated that when students learn something new, they construct their own meaning.

Beside student centered instruction, real-world applications must be used during instruction. Introducing real-world applications to mathematics classes was one of the best educational ways of motivating students in classes. Probability was an area of mathematics with many interesting applications and it was the branch of mathematics concerned with making rational statements about phenomena that posses an element of uncertainty. When mathematical probability was used correctly, it was an effective tool in legal decision-making. Most students in probability classes would find a discussion of its possible uses and misuses in the legal profession interesting and stimulating (Halpern, 1987). Probability was the study of like hood and uncertainty. It played a critical role in all of the professions and in most everyday decisions (Halpern, 1996, p.142).

Another point was to improve students' conceptions. To improve students' conceptions of randomness and probability, Green advocated experimental activities and encouraged explicit classroom discussion of the language of probability. Because Green found that the students' verbal abilities were inadequate for describing probabilistic situations. In the study of Fischbein and Gazit (1983). They taught 9 classes of older children (10-13years) probability up to simple and compound events. They found a clear improvement with age and found two biased intuitions were improved by teaching- the representativeness tendency and the negative regency tendency.

Also Konold (1991) reported on beliefs of college students about probabilities. In his study, he based much of his work on direct interview with students who explained to him their thought process when addressing certain probability problems. There were several models discussed in the study of Kahneman, Slovic, and Tversky (1982), Garfield and Ahlgren (1988) or Konold (1989).

In Turkey, there were few studies on teaching probability (e.g. Bulut, 1994; Cankoy, 1989). Bulut (1994) and Cankoy (1989) conducted study on 8th grade level. Bulut found that students taught by cooperative learning method scored significantly better on the Probability Achievement Test than those taught by traditional lecture method. However, there were no statistically significant mean differences on PAT scores among any other pairs of groups. Cankoy (1989) found that there was a significant mean difference in the favor of the mathematics laboratory group over those taught traditionally.

## 2.3. Difficulties in Teaching and Learning Probability

There was an abundance of research that documents difficulties students and adults had reasoning with probabilistic information.

Garfield and Ahlgren (1988) found evidence that novices and experts alike encounter difficulties with respect to understanding probabilistic concepts. They identified three primary sources for this difficulty:

- Inadequately developed rational number concepts and proportional reasoning;
- Conceptual conflict between formal probabilistic ideas and everyday experience;
- The abstract methods traditionally used in mathematics instruction.

Also some other researchers reported other difficulties listed below:

- Probability ideas often appear to conflict with students' experiences and how they view the world (Kapadia, 1985).
- Students develop distaste for probability through having been exposed to its study in a highly abstract and formal way (Garfield and Ahlegen, 1988).
- Difficulties in translating verbal problem statements plague stochastics as they do the rest of the school mathematics (Hansen, McConn, and Myers, 1985).
- They have difficulty in interpreting the problems (Mosteller, 1967; Carpenter et al., 1981).
- They have difficulty in determining the probability of compound events (Carpenter et al., 1981).
- They can not understand the idea of "Conditional Probability" (Bar- on and Or-Bach, 1988).
- The less able pupils have difficulty with thinking of probability of occurrence of events as a continuum ranging from "certain" to "impossible" (Baron & Or-Bach, 1988).
- They perceive interdependence between unrelated events, i.e. Gambler's Fallacy (Hope & Kelly, 1983).

Adults as well as children confused probability concepts and had some difficulties in problem solving. For example, Hope and Kelly (1983) pointed out that people:

- Are unaware of highly ambiguous everyday expressions of probability;
- Have undue confidence in the reliability of small samples;
- Have a tendency to confuse the categories of unusual events with those of low probability events;
- Have difficulty estimating the frequency of many salient or memorable events.

## 2.4. Misconceptions on Probability

Students did not come to the class as a “blank slates” (Resnick, 1983). Instead, they came with theories constructed from their everyday experiences. They had actively constructed these theories, an activity crucial to all successful learning. Some of the theories that students used to make sense of the world were, however, incomplete half-truths (Mester, 1987). These were misconceptions.

Misconceptions were the subcategory of pre-instructional conception, which was contradictory with the mathematical concepts. They did not simply signify a lack of knowledge, factual errors, or incorrect definitions. They represented explanations of phenomena constructed by students in response to their prior knowledge and experience.

Misconceptions were a problem for two reasons. First, they interfered with learning when students used them to interpret new experiences. Second, students were emotionally and intellectually attached to their misconceptions, because they had actively constructed them. Hence, students gave up their misconceptions, which could have a harmful effect on learning, only with a great reluctance.

What do these findings mean? They showed teachers that their students almost came to class with complex ideas about the subject at hand. Further, they suggested that repeating a lesson on making it clearer would not help students who based their reasoning on strongly held misconceptions (Champagne, Klopfer & Gunstone, 1982; McDermatt, 1984; Resnick, 1983). In fact, students who overcame a misconception after ordinarily instruction often returned to it only a short time later. Simply lecturing to students on a particular topic would not help most students gave up their misconceptions. Since they actively constructed knowledge, teachers must actively help them dismantle their misconceptions. Teachers must also help students reconstruct conceptions capable of guiding their learning in the future.

Remediation of misconceptions could be achieved with the help of teachers. So teachers had the important role and they should be very well prepared for teaching mathematics.

In probability, there were some studies about misconceptions. A different approach to misconceptions in probability was by Amir and Williams (1995). They stated that some intuitions, inclinations and biases might be affected by cultural factors. As a result of their study, they found certain intuitions, approaches; biases and heuristics noted in literature take a strong and common forming 11 year old thinking, e.g. the outcome approach, Representativeness, availability, equiprobability. In addition, Fichbein, Nello and Marino also indicated that cultural influences on probabilistic reasoning might be important.

Another study about attempts to remedy probabilistic misconceptions resulted in course designs which combine conceptual instruction and experience with stochastic events (e.g., Beyth-Marom &Denkel, 1983).Students did not appear to have good intuitions about stochastic events. Green (1982) observed that adolescents became less likely to identify random sequences correctly with age. A lack of opportunity to explore systematically the characteristics of stochastic events was assumed to be a major source of students' misconceptions. Experience with games of chance which reward "good intuitions" (Obremski, 1981) were incorporated into instructional units on probability as a means for providing such opportunities. Although Obremski (1981) recommended the use of games of chance, no direct assessment of their effectiveness in reducing misconceptions was presented

Newer approaches suggested an active learning format where students first made predictions about the chance of occurrence for different outcomes, then did experiments with random devices such as spinners, dice and coins, record their results and compare the experimental probabilities generated to their original predictions. Indeed, several researchers recommended this method as a way to encourage students to confront and correct their misconceptions about chance events (e.g. Batanero, Serrano & Garfield; Godino et al, 1987; delMas & Bart, 1989; Shaughnessy, 1992).

In Turkey, there were few studies on misconceptions on probability (e.g., Yıldız & Bulut, 2002; Mut, 2004). Yıldız and Bulut (2002) conducted a study on preservice mathematics teachers in Ankara. They found that preservice mathematics teachers had misconceptions on probability. Mut (2004) studied with students' grade level between 5 to 10. He found that frequencies of misconception types varied across gender and grade levels. He also found that the percentages of students who received instruction in probability were higher than those who did not received instruction in terms of misconceptions on Effect of Sample Size and the Time Axis Fallacy.

## 2.5. Gender Differences in Mathematics

There had been a large body of investigations of gender differences in mathematics and science education to try to determine if the myth was true that females were less capable of doing mathematics than males (Marshall, 1984; Leder, 1992; Gallagher & Delisi, 1994; Levi, 2000; Linn & Hyde, 1989).

Marcia C. Linn, a leading researcher on gender differences in math education, studied this subject for over twenty years. In her earlier studies she found that there were some gender differences in mathematical processing and that boys did this well than girls. She found in her later studies, however, that this was not the case, that the gap had closed substantially (Linn & Hyde, 1989). In fact, even though middle school students thought that boys were better than girls in mathematics and science, this was not true. They were at least equal and in many cases, the girls surpassed the boys. Linn now claimed that the main gender difference was in the confidence level of the student (which may be influenced by gender).

In their study, Damarin (1995) and Leder (1992) stated that the commonly supported societal belief that mathematics is male oriented domain demonstrates that the differences in mathematics disadvantageous to girls aroused from social and cultural reasons .Leder also pointed out that males express the need for mathematics for better occupational opportunities than females.

Marshall (1984) found that girls were better than boys in solving computations, whereas boys were better than girls in solving story problems. Kimball (1989) focused on the differences between girls' and boys' approaches to mathematics learning. Beller and Gafli (2000) boys performed better than girls.

According to Kimball and Marshal (1984), gender differences in mathematics achievement did not appear in early ages of education, however the differences were seen after junior high school years.

We could reach several international studies on gender differences on probability. Dusek and Hill (1970) and Kreitler, Zigler and Kreitler (1983) found that males outperformed significantly than females. In their study, Kreitler, Zigler and Kreitler conducted research on 10th grade students and Dusek and Hill studied with 4th and 5th grade level students. In 1979, Moran and Mccullars found female 1st year university students had significantly higher mean scores than males had. Hanna (1986) stated there was no significant mean difference with respect to 8th grade grade students' probability achievement.

In our country, in 1994, Bulut found that 8th grade female students had significantly higher mean score on probability achievement than males had. In their study, Bulut, Yetkin and Kazak (2002) stated that there was a statistically significant mean difference on preservice secondary mathematics teachers' probability achievement in favor of male. Also in his study Mut (2004) found that the frequencies of all misconception types varied across gender.

# CHAPTER 3

# METHOD

This chapter presents the design of the study, main and sub problems, definition of terms, variables, population and sampling, instruments, procedure, analysis of data, and assumptions and limitations parts.

## 3.1. Research Design of the Study

The purpose of the study was to examine the factors affecting preservice mathematics teachers' decisions on probability teaching. Therefore the study was a correlational study.

During the study four different tests and scales were administered:

- Probability Achievement Test (PAT): It includes open-ended questions.
- Probability Misconception Test (PMT): The test is consisting of probability problems in a multiple choice format. The alternatives of each item are either true or false or misconceptions that students can have. The aim is to find the misconceptions students have.
- Attitude towards Probability Teaching Scale (APTS): This scale is administered to determine preservice mathematics teachers' attitude towards probability teaching.
- Attitude towards Probability (APS): It is administered to determine preservice mathematics teachers' attitude towards probability.

To explain the results of the correlational study and to examine the third sub-problem, qualitative analysis was accomplished.

After analyzing of data, 12 students were chosen; 6 from preservice mathematics teachers, 6 from preservice science teachers according to their score from APTS. Then 15 minutes interviews were done with each subject.

### 3.2. Main and Sub problems of the Study

The main research problem of the present study was the following:

"What are the factors affecting preservice mathematics teachers' decisions on probability teaching?"

The sub-problems related with the main problem are as follows:

*Sub-problems*:

- How well can attitudes toward probability teaching be explained in terms of gender, probability achievement, and attitudes toward probability?
- What are the preservice mathematics teachers' misconceptions about?
- How do preservice mathematics teachers' experiences on probability affect their view about teaching probability?

### 3.3. Hypothesis of the Study:

To examine the first sub-problem test, the following null hypothesis was stated:

The three variables together (probability achievement, attitudes toward probability, and gender) do not explain a significant amount of variance in preservice teacher's attitudes toward probability.

It was tested at the significance level of 0.05

### 3.4. Definition of Terms

In this section, some terms that are used in the present study were defined to be clear to prevent any misunderstanding.

- *Representativeness (Fallacy of Regression):* People will predict the like hood of events based on how well an outcome represents some aspect of its parent population.
- *Negative and Positive Recency Effect:* Negative recency effect is the tendency to predict an outcome, which has not appeared for some time in a series of trials. It has been the "Gambler's Fallacy". This is related to heuristic of Representativeness. After the repeated occurrence of one outcome, a gambler comes to believe that probability of the alternative outcome is increasing even though successive events are independent. The converse of this is a tendency to predict an outcome, which has repeatedly occurred.
- *Simple and Compound Events:* Students confuse or do not separate these events.
- *Conjunction Fallacy:* The probability of an event appears under certain conditions, to be higher than the probability of the intersection of the same event with another event.
- *Effect of Sample Size:* Students tend to neglect the influence of the magnitude of a sample when estimating probabilities. Representativeness also occurs when students neglect the sample size.
- *Availability of Heuristics:* The tendency to make predictions based on how accessible instances of an event are to the memory or on how easy it is to construct particular instances of events. The judgmental heuristic can induce significant bias because of one's own narrow experience or personal perspective. We all have egocentric impressions off the frequency of events based on our own experiences. Often these impressions are biased.
- *Time Axis Fallacy (Effect of the Time Axis): C*hildren may assign a role in chance events to the personal qualities of the player though objectively such an effect does not exist. An inversion of the time axis of cause implying effect contradicts one of our basic intuitions.
- *Misconception:* A misconception is an underlying belief that governs an error.
- *Probabilistic Thinking:* It is used to describe children's thinking in response to any probability situation.

- *Experience on Probability:* Knowledge of probability gained during probability instruction.
- *Probability Achievement*: It refers to score subjects got from PAT.
- *Attitude toward Probability Teaching*: It refers to subjects' scores From APTS.
- *Attitude toward Probability Scale*: It refers to the subjects' scores from APS.
- *Preservice Mathematics Teacher*: It refers to subjects who were students in Elementary School Science Education and Elementary School of Mathematics Education.

### 3.5. Variables

There was one dependent variable in the study related to preservice mathematics teachers' attitude toward probability teaching. For this dependent variable, there were four independent variables: Probability achievement, attitude toward probability, probabilistic misconceptions and gender.

### 3.6 Subject of the study

The study was carried out during the spring semester of 2002-2003 academic year.

There are 104 preservice mathematics teachers from Gazi University, 107 preservice mathematics teachers from Hacettepe University, and 37 preservice mathematics teachers from Middle East Technical University. The distribution of the subjects with respect to gender is given in the following Table 3.1.

Table 3.1 Distribution of students with respect to Gender

| Gender | n | Percent |
|---|---|---|
| Female | 170 | 68,5 |
| Male | 78 | 31,5 |
| Total | 248 | 100 |

After the analysis of APTS students were named as low score achievers, middle score achievers and high score achievers. According to the scores taken from APTS, 12 students were chosen for interview; 6 of whom were preservice mathematics teachers and 6 of whom were preservice science teachers. 2 preservice mathematics teachers and 2 preservice science teachers were low achievers; the other 2 preservice science and mathematics teachers were middle score achievers; the last twos were high score achievers for the interview

## 3.7 Measuring Instruments

In the present study, the following measuring instruments were used:

- Probability Achievement Test (PAT)
- Probability Misconception Test (PMT)
- Attitude towards Probability Teaching Scale (APTS)
- Attitude towards Probability Scale (APS)
- Interview questions

### 3.7.1 Probability Achievement Test

PAT was developed by Bulut in 1994. (Appendix A). It was used to determine the students' probability achievement. The test was used in this study had some changes.

The test was administered to 198 fourth grade students of preservice mathematics and science teachers from Gazi University, Middle East Technical University and Hacettepe University in spring semester of 2002-2003 academic year.

In the present study, the Cronbach Alpha was found as 0.96

### 3.7.2 Probability Misconception Test

The test was composed of 13 multiple choice questions. The items were taken from the test developed by Mut (2004).The questions were world wide known misconception questions. The test was presented in the Appendix B.

The questions were coded according to the name of alternatives. For example, it was assumed that the item had 4 alternatives a, b, c and d. They were coded as 1, 2, 3, and 4 respectively. One of them was misconception, another was correct and the other alternatives were incorrect. If the subject did not choose any of the alternatives, his/her answer was coded as NA which meant no answer. If the subject did not choose any of the alternative and showed his/her answer, then it was coded as OA which meant his own answer. In SPSS program alternatives were labeled as misconception, correct and incorrect. The percentages and the frequencies of each alternative were computed.

The questions and misconception types are given as following:

Questions 1 and 2 tested for misconception on Representativeness. They were also used in the studies done by Kahneman and Tversky (1972); Shaughnessy (1992); Tversky and Kahneman (1982). The questions are stated below:

Question 1: Say you flip an ordinary quarter several times in successions with H representing a Head coming up and T representing a Tail. The notation HT means in two successive flips a Head occurred followed by a Tail. If you flip a quarter 5 times in succession, which of the following sequences are you most likely to observe:

a) TTTHH (incorrect)

b)THHTH (incorrect)

c) HTHHH (incorrect)

d) THTHT (main misconception)

e) Among (a)-(d) one is likely as the other (correct)

Question 2: In a lotto game, one has to choose 6 numbers from a total of 40. Ahmet has chosen 1, 2,3,4,5, and 6; Nuray has chosen 39, 1, 17, 33, 8 and 27. Who has a greater chance of winning?

a)Ahmet (incorrect)

b) Nuray (main misconception)

c) Ahmet and Nuray have the same chance of winning. (correct)

Question 3 and 4 tested for misconception on Negative and Positive Recency Effects. They were used in the studies done by Cohen, 1957; Fischbein, 1975; Fischbein, Nello & Marino (1991). The questions are given below:

Question 3: When tossing a coin, there are two possible outcomes: either heads or tails. Özge flipped a fair coin three times and in all cases tails came up. Özge intends to flip the coin again. What is the chance of getting heads at the fourth time?

a) Equal to the chance of getting tails. (correct)

b) Greater than the chance of getting tails (main misconception)

c) Smaller than the chance of getting tails. (incorrect)

Question 4: A father plays the following game with his son: The father hides a coin in one of his hands behind his back, and if his son knows in which hand he hides the coin, he wins the coin. The past 14 days (or hands), the son wins 5 times and looses 9 times. Which of the following options would you expect to happen the next 14 days (or hands)?

a) The son wins more than he looses. (main misconception)

b) The son looses more than he wins. (incorrect)

c) The number of the games he looses is equal to the number of games he wins. (correct)

Questions 5 and 6 tested for misconception on Simple and Compound Events. They were also used in the studies done by Lecoutre and Durant (1988). The questions are stated below:

Question 5: Suppose one rolls a dice simultaneously. Which of the following has a greater chance of happening?

a) Getting the pair of 6-6 (incorrect)

b) Getting the pair of 5-6 (correct)

c) Both have the same chance (main misconception)

Question 6: The letters in the word "**ÇİÇEK**" are written one by one on the cards and then these cars are placed in a bag. What is the probability of getting the letter "**Ç**" from this box at random?

a) $\frac{2}{5}$ (correct)

b) $\frac{2}{3}$ (incorrect)

c) $\frac{1}{4}$ (main misconception)

Questions 7 and 8 tested for misconception on Effect of Sample Size. They were also used in the studies done by Tversky and Kahneman (1982). The questions are given below:

Question 7: A doctor keeps the records of newborn babies. According to his records, the probability of which of the following options is higher?

a) Out of the first 10 babies, the gender of 8 or more of them is female.(correct)

b) Out of the first 100 babies, the gender of 80 or more of them is female.(incorrect)

c) The probability of events (a) and (b) is the same.(misconception)

Question 8: The likehood of getting tails at least twice when tossing three coins is:

a) Smaller than (incorrect)

b) Greater than (correct)

c) Equal to (main misconception)

the likehood of getting tails at least 200 times out of 300 times.

Question 9 tested for the misconception on Conjunction Fallacy. It was used also in the study done by Shaughnessy, 1992; Tversky & Kahneman(1983). The question is written below:

Question 9: Fatih dreams of becoming a doctor. He likes to help people. When he was in high school, he volunteered for Kızılay organization. He accomplished his studies with high performance and served in the army as a medical attendant. After ending his army service, Fatih registered at the university. Which seems to you to be more likely?

a) Fatih is a student of the medical school. (main misconception)

b) Fatih is a student. (correct)

Question 10 tested for the misconception on Heuristics Availability. It was also used in the studies done by Tversky and Kahneman (1973). The question is stated below:

Question 10: **K**: The number of groups composed of 2 members from among 10 candidates.

**L**: The number of groups composed of 8 members from among 10 candidates.

According to the given information above, which of the following is correct?

a) K is greater than L (main misconception)

b) K is smaller than L (incorrect)

c) K is equal to L (correct)

Questions 11 and 12 together tested for the misconception on the Time Axis Fallacy (also called the Falk Phenomenon). In these questions, people are likely to answer 11th question correctly, then 12th question differently on the basis of the principle that an event can not retroactively on its cause. The response for the questions 11 and 12 are driven into three categories: In category I, both responses are correct; in category II, the 11th response is correct while the 12th is incorrect; and in category III both responses are incorrect. Category II represents the main misconception. An inversion of the time axis of cause implying effect contradicts one of our basic intuitions. They were also used in the studies done by Falk, 19799; Shaughnessy (1992) and Fsischbein (1997). The questions are stated below:

Question 11: Dilek receives a box containing two white marbles and two black marbles. Dilek extracts a marble from her box and finds out that it is a white one. Without replacing the first marble, she extracts a second marble. According to this information which of the following is correct?

a) The likehood that the second marble is also white equal to the likehood that it is black marble.

b) The likehood that the second marble is also white greater than the likehood that it is a black marble.

c) The likehood that the second marble is also white smaller than the likehood that it is a black marble.

Question 12: Ahmet receive a box containing two white marbles and two black marbles. Ahmet extracts a marble from his box and puts it aside without looking at it. He then extracts a second marble and sees that it is white. According to this information which of the following is correct?

a) The likehood that the first marble he extracted is white greater than the likehood that it is a black.

b) The likehood that the first marble he extracted is white smaller than the likehood that it is a black.

c) The likehood that the first marble he extracted is white equal to the likehood that it is a black.

Question 13 tested for misconception on Equiprobability Bias. It was also used in the studies done by Green (19983). The question is given below:

Question 13: There are six fair dies each of which is an ordinary cube with one face painted white and other faces painted black. If these dies are tossed which of the following would be more likely?

a) You would observe 5 black and 1 white. (correct)

b) You would observe 6 white. (incorrect)

c) One is as likely as the other. (main misconception)

### 3.7.3 Attitude towards Probability Scale

APS was developed by Bulut and mathematics education students who attended ScE 352 "Applied Statistics" course at METU in the spring semester of the 1991-1992 academic year. The scale was presented in the Appendix D.

The scale consisted of 28 items of 15 positive and 13 negative items and it was scaled on a six-point Likert Type scale: Strongly Agree, Agree, Tend to disagree, disagree, and Strongly Disagree.

In the present study, the Cronbach Alpha was found as 0.95. The total score of APS was between 28 and 168.

The scale was used to asses students' attitude towards probability.

### 3.7.4 Attitude towards Probability Teaching

APTS was developed by the researcher. The scale was given in the Appendix C. The scale was used to assess the students' attitude toward probability learning. The procedure followed in the development of APTS is outlined below.

The item bank for APTS was derived from:

a) scales of attitudes towards mathematics,
b) observations of people's attitude toward probability,
c) beliefs about mathematics.

The item bank consisted of 61 items related to attitude toward probability learning. All items were written in Turkish. From this item bank, 35 items were selected.

The pilot study of 35 item scale was done with 196 preservice mathematics teachers from Gazi and Hacettepe Universities in the spring semester of 2002-2003 academic year. It was analyzed by using "Statistical Packages for Social Sciences" (SPSS). And an 18-item APTS was formed. It consisted of 12 positive items and 6 negative items and was scaled on a five-point Likert Scale: Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Items were scored starting from strongly agree as 5, to strongly disagree as 1, and negatively worded items were reversed to a positive direction for scoring purposes.

To test construct validity of APTS and to find sub dimensions, factor analysis was done. According to the initial principle factor solution with iterations, the first six eigenvalues were 7.92, 1.34, and 1.26,1.06. Factor loadings of APLS in the first (general) factor ranged between 0.81 and 0.66. The first factor accounted for 44.02 % of the total variation in the APTS scores. For the purpose of analyzing the factor structure of the scale more precisely, this primary factor solution was rotated by the use of the varimax rotation. The eigenvalues were obtained as 4.04, 3.37, 2.16, and 2.01. The first factor explained 22.49% of the variation of the total scores of the APLS. The factor loadings with the values at .35 or above are presented in Table 3.2.

Table 3.2. Varimax Rotated Factor Loadings for the APTS

| Item No | Factor 1 Confidence | Factor 2 Enjoyment | Factor 3 Anxiety | Factor 4 Importance |
|---|---|---|---|---|
| 16 | 0.81 | | | |
| 12 | 0.79 | | | |
| 4 | 0.73 | | | |
| 18 | 0.73 | | | |
| 8 | 0.66 | | | |
| 9 | | 0.81 | | |
| 1 | | 0.77 | | |
| 5 | | 0.68 | | |
| 13 | | 0.66 | | |
| 6 | | | 0.38 | |
| 2 | | | 0.35 | |
| 17 | | | 0.31 | |
| 10 | | | 0.75 | |
| 14 | | | 0.67 | |
| 11 | | | | 0.75 |
| 15 | | | | 0.63 |
| 3 | | | | 0.60 |
| 7 | | | | 0.51 |

When items accumulated in each factor in the table are written in open forms, it can be easily seen that items in each group have a common point as a group. Thus, the items accumulated in each factor in the table could be named as a sub dimension providing the evidence for construct validity of the APTS. The sub dimensions were named as confidence, enjoyment, anxiety and importance of probability teaching respectively.

In the present study, the Cronbach Alpha was found as 0.92.The total score of APTS was between 18 and 90.

### 3.7.5 Interview Questions

The researcher thought that a semi-structured interview format with open-ended questions would yield information needed to answer the research questions.

While preparing the interview structure, the researcher considered the following issues:

- What questions to ask;
- How to sequence the questions;
- How much detail to solicit;
- How long the interview last;
- How to word the actual questions;

Three sets of interview schedules, one was for probability education background before university, one was for probability education background during university, one was for probability teaching as a teacher, were prepared by the researcher (Appendix E).

The questions were prepared in Turkish and were checked by the expert in terms of clarity and content-specificity. Some questions were revised, changed or dropped.

After implementing the necessary revisions to instruments, the researcher started data collection procedure. The researcher and the interviewees decided the interview calendar. After making appointments with interviewees, the researcher did the followings in all interviews:

Before the interview started the researcher gave standard information to interviewees; the purpose of study, who would use the interview data, and recording technique. All the interviews were tape-recorded. The interviews took 15-20 minutes. At the end of the interview the researcher thanked for time and effort.

Then the researcher transcribed 200 minutes took interview notes word by word from tape she had recorded during the interview with the help of transcriber. The researcher generated approximately 30 word-processed pages of raw data. The transcript was formatted by leaving the left margin as wide as 5 inches in order to allow sufficient space for writing comments, taking notes and assigning codes for further analysis.

The data collected through, interviews were analysed by categorizing the data under themes according to the answers to questions in the interview schedule. For this purpose, similar responses were grouped and different responses were added.

The frequencies and percentages were drawn from data.

### 3.8 Procedure

The present study started with a review of literature about the intended components of the research question. The data collection instruments were selected and one was developed. Probability Achievement test was changed and Attitude towards Probability Teaching Scale was developed and both were piloted with preservice mathematics teachers in June 2002. According to results of the pilot study, Attitude towards Probability Teaching Scale was revised. After the pilot study, in the spring semester of 2002-2003 academic year 248 preservice mathematics teachers from Gazi, Hacettepe and Middle East Technical Universities were administered all instruments. There were no time limitations. First the two attitude scales were administered; APS and APTS. then the PAT and PMT were administered respectively. All necessary instructions were read before administration and reminded when needed during administration.

Then these 12students were interviewed for 15-30 minutes in a semi structured interviews.

### 3.9 Analysis of Data

Data analysis procedure of this study was conducted in the following steps:

- Data collected from subjects were coded and were transferred to computer environment with MS Excel and SPSS package program.
- Probability of doing Type I error was set at 0.05 level.

- Interviews were transcribed.
- Some conclusions were drawn from interviews.

### 3.10 Assumptions and Limitations

As in other studies there were several assumptions and limitations of the present study. The main assumptions of the present study were the following:

- The administration of the test and scales were completed under standard conditions.
- All the subjects of the pilot and experimental studies answered the measuring instruments accurately and sincerely.
- The students answered the interview questions sincerely.
- There was no interaction between the subjects to affect the results of the present study.

The followings are the limitations of the present study:

- This study was limited to preservice mathematics students from Gazi, Hacettepe and Middle East Technical Universities during the spring semester of 2002-2003 academic year.
- Semi structured interview technique which require the subject to respond truthfully and willingly were used.

# CHAPTER 4

# RESULTS

In the previous chapters, the theoretical background of the study, the review of related literature and the method of the present study were stated. In this chapter, the result of the analyses that were conducted to obtain statistical evidence for our claims would be presented. This chapter contained three sections. The first section contained the problem of the present study examined by means of associated hypothesis. In the second section, the analysis of misconceptions with respect to gender was included. The results of the interview were included in the third section.

The purpose of the present study was to examine the factors affecting preservice mathematics teachers' decisions on probability teaching.

## 4.1. Results of Testing Hypothesis

In this section first sub-problem of the study was examined by means of associated hypothesis.

The sub-problem of the present study stated as: "How well can preservice mathematics teachers' attitude toward probability teaching be explained in terms of their attitude toward probability, probability achievement and gender."

For investigating this sub-problem, one hypothesis was stated and was given below:

*The three variables together (preservice mathematics teachers' attitude toward probability, probability achievement and gender) do not explain* *a significant amount of variance in their attitude toward probability teaching.*

There was no high correlation among probability achievement, attitude toward probability and gender. In other words, there was no multicollinearity among independent variables.

The stated hypothesis was examined by using Linear Stepwise Regression at a significant level of 0.05. The results are given in Table 4.1.

Table 4.1 Linear Stepwise Regression Analysis Results for the Significant Predictor Variable on Probability Teaching of Preservice Mathematics Teachers

| Regression Statistics | | | | | |
|---|---|---|---|---|---|
| Multiple R | 0.740 | | | | |
| R Square | 0.548 | | | | |
| Adjusted R Square | 0.546 | | | | |
| Standard Error | 5.1851 | | | | |
| | df | SS | ms | F | Sig. F |
| Regression | 1 | 7993.043 | 7993.043 | 297.307 | 0.000 |
| Residual | 245 | 6586.787 | 26.885 | | |
| Total | 246 | 14579.830 | | | |

*$p < 0.05$

As in Table 4.1 indicates, the one variable (preservice mathematics teachers' attitude toward probability) explained a significant amount of variance in their attitudes toward probability teaching, $R^2$=0.548, adjusted $R^2$=0.546

($F(1,246)=297.307$, $p<0.05$). 54.8 percent of the variances on scores of attitude toward probability teaching scale are explained by this variable.

The individual effect of the predictor can be seen in Table 4.2. According to this table, preservice mathematics teachers' attitude toward probability explained a significant amount of variance in their attitude toward probability teaching ($p<0.05$).

Table 4.2 Linear Stepwise Regression Analysis Results for Effect of Preservice Mathematics Teachers' Attitude toward Probability on Probability Teaching of Preservice Mathematics Teachers

| Variables | Standardized Coefficients | Standard Error | T Ratio | P values |
|---|---|---|---|---|
| AtP | 0.740 | 0.013 | 17.243 | 0.000* |

p*<0.05

Using Table 4.2, a linear stepwise regression equation could be written in order to estimate probability teaching of preservice mathematics teachers from one significant variable. The regression equation with one predictor was significantly related to attitude probability teaching of preservice mathematics teachers. This equation was:

$y=0.740x_1$

Where y represented the predicted attitude toward probability teaching of preservice mathematics teachers and $x_1$ represented preservice mathematics teachers' attitude toward probability.

Preservice mathematics teachers' probability achievement and gender were excluded from the equation because they did not have a significant contribution to variance in probability teaching of preservice mathematics teachers ($p>0.05$).

The Table 4.3 showed the results of linear stepwise regression analysis of two excluded variables.

Table 4.3 Results of Linear Stepwise Regression Analysis of two Excluded Variables

| Variables | Beta In | t | p value | Partial correlation | Tolerance |
|---|---|---|---|---|---|
| PA | 0.51 | 1.156 | 0.249 | 0.074 | 0.948 |
| Gender | 0.004 | 0.095 | 0.925 | 0.006 | 0.986 |

To asses the extent to which preservice mathematics teachers' attitude toward , probability achievement and gender could account for their attitude toward probability teaching, a linear stepwise regression was performed with probability teaching of preservice mathematics teachers on attitude toward probability and probability achievement and gender of preservice mathematics teachers. As can be seen in table 4.2, only preservice mathematics teachers' attitude toward probability was the significant variable. However as seen in Table 4.3 the two variables (probability achievement and gender) were not significant predictors.

## 4.2 Misconceptions on Probability

In this section, misconceptions on probability of preservice mathematics teachers were given with respect to gender and whole subject.

### 4.2.1. Misconceptions on Probability w.r.t to Gender

In this section, misconception types were analysed with respect to gender. The misconception types were: Representativeness, Positive and Negative Recency Effects, Simple and Compound Events, Effect Sample Size, Conjunction Fallacy, Heuristic Availability, The Time Axis Fallacy, and Equiprobability Bias are analyzed with respect to gender.

Although there had been several studies that had found gender differences in different fields of mathematics (Gallegher, De Lisi, 1994; Halpern, 1997; Kimbal, 1989), not only in Turkey but also in other countries the effect of gender differences on probability has not been studied sufficiently.

#### 4.2.1.1 Misconception on Representativeness w.r.t Gender

The 1st and the 2nd questions related to misconception on "Representativeness" were examined by taking into account gender. The distribution of misconception type Representativeness w.r.t gender was given in Table 4.4 and Table 4.5.

Table 4.4 Percentages and Numbers of Students' Answers for Question 1 w.r.t Gender

| Gender | | NA | OA | I | I | I | M | C |
|---|---|---|---|---|---|---|---|---|
| M | % | 1.3 | - | - | - | 2.6 | 3.9 | 92.2 |
| | N | 1 | - | - | - | 2 | 3 | 71 |
| F | % | 0.6 | - | 0.6 | - | 0.6 | 1.8 | 96.5 |
| | N | 1 | - | 1 | - | 1 | 3 | 164 |

Table 4.5 Percentages and Numbers of Students' Answers for Question 2 w.r.t Gender

| Gender | | NA | OA | I | M | C |
|---|---|---|---|---|---|---|
| M | % | - | - | 1.3 | 3.9 | 94.8 |
| | N | - | - | 1 | 3 | 73 |
| F | % | - | - | 0.6 | 2.4 | 97.1 |
| | N | - | - | 1 | 4 | 165 |

The 1st and 2nd questions investigated Representativeness misconception type w.r.t gender. The misconception was not frequent among male and female students. It could be stated that Representativeness did not across gender.

#### 4.2.1.2 Misconception on Positive and Negative Regency Effect w.r.t Gender

The 3rd and the 4th questions related to misconception on "Positive and Negative Regency Effect were examined by taking into account of gender. The distribution of misconception type "Positive and Negative Regency Effect" was given in Table 4.6 and Table 4.7.

Table 4.6 Percentages and Numbers of Students' Answers for Question 3 w.r.t Gender

| Gender | | NA | OA | C | M | I |
|---|---|---|---|---|---|---|
| M | % | - | 1.3 | 96.1 | 2.6 | - |
| | N | - | 1 | 74 | 2 | - |
| F | % | 1.2 | - | 97.1 | 1.2 | 0.6 |
| | N | 2 | - | 165 | 2 | 1 |

Table 4.7 Percentages and Numbers of Students' Answers for Question 4 w.r.t Gender

| Gender | | NA | OA | M | I | C |
|---|---|---|---|---|---|---|
| M | % | 10.4 | 14.3 | 6.5 | 15.6 | 53.2 |
| | N | 8 | 11 | 5 | 12 | 41 |
| F | % | 8.8 | 8.8 | 8.2 | 22.4 | 51.8 |
| | N | 15 | 15 | 14 | 38 | 88 |

The 3rd and 4th questions investigated the misconception type "Positive and Negative Regency Effect"

In the 3rd question both male and female students have less frequent misconception than in the 4th question. But in the 3rd question females had less frequent misconception than males; where in the 4th question males had less frequent misconception than females.

Since both 3rd and 4th questions investigated the same type of misconception, it could be stated that both males and females had not frequent misconception on Positive and Negative Regency Effect.

### 4.2.1.3. Misconception on Simple and Compound Events w.r.t Gender

The 5th and the 6th questions related to misconception "Simple and Compound Events" were analyzed by taking into account of gender.

The distribution of misconception type "Simple and Compound Events" w.r.t gender was given in Table 4.8 and Table 4.9.

Table 4.8 Percentages and Numbers of Students' Answers for Question 5 w.r.t Gender

| Gender | | NA | OA | I | C | M |
|---|---|---|---|---|---|---|
| M | % | 1.3 | - | 1.3 | 143 | 83.1 |
| | n | 1 | - | 1 | 11 | 64 |
| F | % | 1.2 | 1.8 | 2.4 | 5.9 | 88.8 |
| | n | 2 | 3 | 4 | 10 | 151 |

Table 4.9 Percentages and Numbers of Students' Answers for Question 6 w.r.t Gender

| Gender | | NA | OA | C | I | M |
|---|---|---|---|---|---|---|
| M | % | 2.6 | 2.6 | 85.7 | - | 9.1 |
| | n | 2 | 2 | 66 | - | 7 |
| F | % | 0.6 | 1.8 | 86.5 | 0.6 | 10.6 |
| | n | 1 | 3 | 147 | 1 | 18 |

The 5th and the 6th questions investigated the misconception type "Simple and Compound Events".

In the 5th question, both males and females had a great amount of misconception; where as in the 6th question this amount degreases sharply. But both 5th and 6th questions investigated the same type of misconception, it could be stated that both males and females had misconception on simple and compound events.

#### 4.2.1.4. Misconception on Effect of Sample Size w.r.t Gender

The 7th and the 8th questions related to misconception type "Effect of Sample Size" was analyzed by taking into account of gender.

The distribution of misconception type "Effect of Sample Size" w.r.t gender was given in Table 4.19 and Table 4.11.

Table 4.10 Percentages and Numbers of Students' Answers for Question 7 w.r.t

| Gender | | NA | OA | C | I | M |
|---|---|---|---|---|---|---|
| M | % | 1.3 | - | 16.9 | 5.2 | 76.6 |
| | N | 1 | - | 13 | 4 | 59 |
| F | % | 5.3 | - | 9.4 | 5.9 | 79.4 |
| | N | 9 | - | 16 | 10 | 135 |

Table 4.11 Percentages and Numbers of Students' Answers for Question 8 w.r.t Gender

| Gender | | NA | OA | I | C | M |
|---|---|---|---|---|---|---|
| M | % | 2.6 | - | 5.2 | 19.5 | 72.7 |
| | N | 2 | - | 4 | 15 | 56 |
| F | % | 5.3 | - | 8.2 | 17.6 | 68.8 |
| | N | 9 | - | 14 | 30 | 117 |

The 7th and 8th questions investigated the misconception type "Effect of Sample Size". Both males and females had a high amount of misconception on Effect of ample Size which is above 65%.

#### 4.2.1.5. Misconception on Conjunction Fallacy w.r.t Gender

The 9th question related to misconception "Conjunction Fallacy" was analyzed by taking into account of gender. The distribution of misconception "Conjunction Fallacy" w.r.t gender .was given in Table 4.12.

Table 4.12 Percentages and Numbers of Students' Answers for Question 9 w.r.t Gender

| Gender | | NA | OA | M | C |
|---|---|---|---|---|---|
| M | % | 1.3 | 1.3 | 13 | 84.4 |
| | n | 1 | 1 | 10 | 65 |
| F | % | 1.2 | 2.9 | 20 | 75.8 |
| | n | 2 | 5 | 34 | 129 |

The 9th question investigated "Conjunction Fallacy". The Conjunction fallacy was frequent among males and females.

#### 4.2.1.6. Misconception on Heuristic of Availability w.r.t Gender

The 10th question related to misconception "Heuristic of Availability" was analyzed by taking into account of gender. The distribution of misconception type "Heuristic of Availability" w.r.t gender was given in Table 4.13.

Table 4.13 Percentages and Numbers of Students' Answers for Question 10 w.r.t Gender

| Gender | | NA | OA | M | I | C |
|---|---|---|---|---|---|---|
| M | % | 2.6 | - | 37.7 | 10.4 | 49.4 |
| | n | 2 | - | 29 | 8 | 38 |
| F | % | 4.7 | - | 39.4 | 7.6 | 48.2 |
| | n | 8 | - | 67 | 13 | 82 |

The 10th question investigated "Heuristic of Availability". The frequency of misconception was more or less the same for both males and females.

#### 4.2.1.7. Misconception on Effect of Time Axis (Falk Phenomenon) w.r.t Gender

The 11th and the 12th questions together related to misconception “Effect of Time Axis” was analyzed by taking into account of gender.

The distribution of misconception type “Effect of Time Axis” w.r.t gender was given in Table 4.14.

Table 4.14 Percentages and Numbers of Students’ Answers for Question 11 and 12 w.r.t Gender

| | | | Cat I | Cat II | Cat III | Other |
|---|---|---|---|---|---|---|
| Gender | | NA | C | M | I | I |
| M | % | - | 42.8 | 51.9 | - | 9 |
| | n | - | 30 | 40 | - | 7 |
| F | % | - | 32.3 | 53.5 | 3.5 | 10.5 |
| | n | - | 55 | 91 | 6 | 18 |

Question 11 and 12 together tested “Effect of Time Axis” which was called “Falk Phenomena”. The first category represented the correct answer in which subjects both solved the 11th and12th questions correctly. The second category represented the main misconception in which a student solved the 11th question correctly whereas 12th question was solved incorrectly. The third category represented the incorrect answer where subjects solved both questions incorrect. The category others represented the answers in which the subjects solved the 11th question incorrect and 12th question correct. Both females and males had a frequent misconception of Falk Phenomenon.

#### 4.2.1.8. Misconception on Equiprobability Bias w.r.t Gender

The 13th question related to misconception “Equiprobability Bias” was analyzed by taking into account of gender.

The distribution of misconception type "Equiprobability Bias" w.r.t gender is given in Table 4.15.

Table 4.15 Percentages and Numbers of Students' Answers for Question 13 w.r.t Gender

| Gender | | NA | OA | M | I | C |
|---|---|---|---|---|---|---|
| M | % | 7.8 | - | 28.6 | 59.7 | 3.9 |
| | n | 6 | - | 22 | 46 | 3 |
| F | % | 5.9 | 0.6 | 22.4 | 46.5 | 24.7 |
| | n | 10 | 1 | 38 | 79 | 42 |

The females had a much more tendency to have this misconception than males. It could be stated that Equiprobability bias was frequent among female students.

### 4.2.2 Misconceptions w.r.t Whole

Preservice mathematics teachers' misconceptions on probability was investigated as a whole. The results are given in Table 4.16.

Table 4.16 Misconceptions w.r.t Whole

| Misconception Type | Item # | Misconception %(n) | Correct %(n) | Incorrect %(n) | Other* %(n) |
|---|---|---|---|---|---|
| Representativeness | 1 | 2.4 (6) | 95.2 (236) | 1.6 (4) | 0.8(2) |
| | 2 | 2.8 (7) | 96.4 (239) | 0.8 (2) | |
| Negative/Positive Recency Effects | 3 | 2.0(5) | 96.4 (239) | 0.4 (1) | 1.2 (3) |
| | 4 | 8.1(20) | 52.0 (129) | 20.2 (50) | 19.8(49) |
| Simple & Compound Events | 5 | 87.1(216) | 8.5 (12) | 2.0 (5) | 1.2 (3) |
| | 6 | 10.1(25) | 86.3 (214) | 0.4(1) | 1.2 (3) |
| Effect of Sample Size | 7 | 78.2 (194) | 12.1 (30) | 5.6 (14) | 4.0 (10) |
| | 8 | 69.8(173) | 18.1(45) | 7.7(19) | 4.4 (11) |
| Conjunction Fallacy | 9 | 17.7(44) | 78.2 (194) | - | 4 (10) |
| Availability | 10 | 39.1(97) | 48.4(120) | 8.5(21) | 4 (10) |
| Time Axis Fallacy | 11-12 | 24.1(60) | 34.2(85) | 2.41(6) | 10.0(25) |
| Equiprobability Bias | 13 | 18.1(45) | 24.2 (60) | 50.4 (125) | 18 (10.9) |

(*) Other only referred to "no answer and own answer".

As seen in the table 4.16 most of the subjects did not have misconceptions except questions 5 which was one of the questions examined misconception on the simple and compound; 7, 8 which determined misconception on effect of sample size; 11-12 which determined misconception on Time Axis, 13 which examined the misconception on equiprobability bias.

### 4.3. Interview Results

Interviews were conducted and qualitative data were analyzed. When the subjects were asked what probability means, 67 % of them said "the chance that something will happen" (n=8); 42 % said that probability reminded them about money, head and tail, dice and balls (n=5). The percentage that mentioned about luck, logic, statistic and guess is 8 % (n=1).

When subjects were asked about their familiarity with probability before university, the answers are as follows:

Table 4.17.Familarity with Probability before University

| No Familiarity % (n) | Primary School % (n) | High School % (n) | Private Course % (n) |
|---|---|---|---|
| 8 (1) | 50 (6) | 50(6) | 16 (2) |

%8 of the subjects had no familiarity with probability before university, %50 of them studied probability in primary school, and 50 % of them studied at High school and 16 % of the subjects had probability lessons only during private course.

"During your probability studies before university, how was your teachers' qualification about the subject" was asked to interviewees. The answers were given in Table .4.18.

Table 4.18 Qualification of Teacher about Probability

| Well Qualified % (n) | Qualified % (n) | Normal % (n) | Not Qualified % (n) | Bad Qualified % (n) |
|---|---|---|---|---|
| (1) | 16 (2) | 16(2) | 33(4) | 16(2) |

Only 8 % of the subjects found his/her teacher well qualified about probability. For example student one said his teacher was qualified enough for solving his students' questions. 16 % of them said that their teachers were qualified, 16 % of them found their teachers as normal. 33 % of the subjects saw his/her teachers as not qualified about probability and 16 %of them saw his/her teacher as bad qualified about probability. Student seven said "our teacher solved the probability questions wrong and we showed the right solution to him. Student four said his teacher avoided solving different questions he met. He always solved simple questions.

When the effect of teacher qualification about the probability before university was asked to interviewees, 25 % of them said that teacher qualification had a positive effect on them about probability (n=3). For example, student one said that by encouraging solving problems in different ways, his teacher had a great effect on his interest in probability. Student two said he liked his teacher's teaching style and he learnt a lot from him, at least he learnt enough to solve questions about probability at university entrance examination. 16 % of the subjects believed that their teacher had an effect on their probability learning (n=2). Student six said “My teacher is bad qualified, so I did not get interested in probability.” 16 % of the subjects believed that their teachers’ qualification had no effect during their probability learning (n=2).

Beside the effect of teacher qualification, the interviewees were asked how their teachers’ attitude toward probability was; 33 % subjects said their teacher had a positive attitude toward probability (n=4). Student one said “I saw my teacher gave more importance to probability than to other subjects”. And also student two believed that his teacher’s attitude was positive. 8 %subjects believed that his/her teachers’ attitude was notr( n=1). Student twelve said “My teacher’s teaching style was the same for all subjects”. 41 % of subjects believed that their teachers had negative attitudes toward probability (n=5). Student four said that his teacher bewared of probability. Student five said that his teacher did not give importance to probability. Student six said that his teacher disliked probability.

When the interviewees’ attitudes toward probability learning before university was asked, 50 % of them had positive attitude (n=6), 16 % of them had negative attitude toward probability learning (n=2). For example student one said “My attitude was always positive” and student two said “Since it requires complex thinking, I had always a positive attitude”. Among the subjects who had negative attitude toward probability learning before university, student five said “I do not want to learn”, student twelve said “I never think that it is a very enjoyable subject to learn” and student five said he learnt by memorizing and he did not want to learn probability so he memorized.

The next question was how probability is taught before university, 83 % of subjects of the interviewees complained about how probability was taught (n=10). Student five said that the subject was not thought in detail. Student six said that their teacher did not solve anything different from the book. He added that his teacher did not give daily examples and did not do anything to take his interest. Student four said they solved the same classical examples all the time. 16 % subjects said that basic terms were given in detail and materials were used to get rid of abstract structure of probability (n=2).

Then the interviewees were asked what kind of misconceptions they had, 8 % of them said they had no misconception (n=1). 67 % of them said they had misconception. These misconceptions were simple and compound events (n=8).

After the question about misconception, whether they had difficulty in learning probability or not were asked. The percentages of the given answers are shown in Table 4.19.

Table 4.19 Difficulty in Learning Probability

| Yes<br>% (n) | No<br>%(n) |
|---|---|
| 58 (7) | 33 (4) |

The percentages of interviewees who had difficulty in learning probability before university are 58 %. Both students two, three, four, six, nine, twelve said they had difficulty in learning probability. 33 % of the interviews said they had no difficulty in learning probability before university.

Then the interviewees were asked the factors that affect their attitude toward probability before university. 25 % of them mentioned about teacher as the main factor (n=3). For example, student seven said that his teacher affected him negatively, where as student eight said his teacher affected him positively. 8 % of them said that questions related with probability affected him (n=1), 8 % talked about the teaching method as the main factor (n=1), 8 % of subject said that they enjoyed with probability because of mathematics (n=1).

After these questions about probability during pre-university level, the interviewees were asked in which lessons they met with probability. The results of the given answers were shown in Table4.20.

Table4.20 Courses related with Probability in University

| Mathematics | Statistics & Probability | Development of instructional materials |
|---|---|---|
| 33 (4) | 66 (8) | 8 (1) |

%33 of the interviewees met with probability at university level in mathematics course. % 66 of them met with probability in statistics and probability course and %8 of them met with probability in course on development of instructional material.

When they were asked whether the education about probability at university was sufficient enough to learn and teach, only 16 % subjects said that it was sufficient (n=2). The rest 83 % subjects thought the education about probability was insufficient (n=10). For example student two said more visualization should take part in probability lessons. Also student eight said that more importance could be given to probability teaching. Student nine said that he did not understand why he learnt probability and used very much formula; instead he wondered if they could learn why and how probability came from? Student ten said he did not learn probability and added it was not different from lycee.

When the researcher asked the interviewees whether probability could be thought separately from mathematics or not, 42 % of them said that it could be thought separately from mathematics (n=5) and 58 % of them said it could not be thought separately (n=7). For example student twelve said it could be thought separately because mathematics was full of operations whereas probability required logic. Student five said that it was separate from mathematics since mathematics reminds certainty but probability did not have a certainty. Student eleven said that it could not be thought separately because both of them were related with numbers and logic. Student two said it could not be thought separately because probability's relation with mathematics was very much since it required logical thinking.

Then the researcher asked whether the interviewees did any study about probability in development of instructional material or not and whether it was sufficient or not. 42 % subjects said that they did study about probability but it was not sufficient (n=5). For example student four and three said the logic behind probability could be explained. %58 of the interviewees did not do any study about probability (n=7). For example student six complained about monotony of probability lessons and added that both at high school, and university level, they did the same things.

When how the education taken at university affects their attitudes was asked, different answers were given. These answers were shown in Table4.21.

Table 4.21 University effect on Attitudes

| Negative Effect %(n) | No Effect %(n) | Positive Effect %(n) |
|---|---|---|
| 8(1) | 41(5) | 33(4) |

8 % had negative effect from university education. Student one said that probability at university was very abstract and theoretical. This bored people and effected negatively. 42% of the interviewees said that university education on probability had no effect on their attitudes. Only 33% of them believed university education on probability had positive effect on their attitudes. For example, student eleven said that it affected him in positive way. He added that he enjoyed probability. Student two said that especially the field courses he had taken affected him positively. Student six said he could not learn probability at primary school and High school but he enjoyed probability at university. Student six said he was affected positively and before university he could not solve probability problems when he forgot the formulas. But after university he could solve the problems even if he forgot formulas.

Then the researcher asked the interviewees about their achievement on probability at university. The answers were shown in Table 4.22.

Table 4.22 Achievement on Probability at University

| Good % (n) | Normal % (n) | Bad % (n) |
|---|---|---|
| 66(8) | 8(1) | 25(3) |

66 % of the subjects believed their achievement were good, 8 % thought their achievement level was normal and 25 % of them thought their achievement was bad at university.

Then the researcher asked the effect of achievement on attitude toward probability. 25 % of the interviewees said their attitudes were not affected by achievement (n=3) while 42 % of them said their attitudes were affected by achievement (n=5). For example, student two said that to be successful motivate me positively.

After this question, the interviewees were asked why misconceptions occurred. 42 % of the interviewees said that the teacher was the reason for misconceptions to occur (n=5). For example, student seven said that teacher was very important factor. Teacher should think in detail then should reflect it to students. He added that when something was missing, it was very hard to fill the gaps. Student two said that probability was taught in a very abstract way. Nobody solved examples that made students visualize probability. 16 % of them thought that misconceptions occurred since they did not know the subject completely (n=2). For example, student four said that basic concepts were not understood well, if the concepts were understood, no problem he would meet. 8 % of the subjects said probability was an abstract subject (n=1). 8 % of them believed that misconceptions occurred because of lack of interaction between teacher and students (n=1).

Then the researcher asked the subjects whether they were aware of their misconceptions and whether previous misconceptions were continuing and news occurred or not. 33% of the students said that they were aware of their misconceptions (n=4). 42% of the subjects said that they were aware of their misconceptions (n=5). 25% of the interviewees said their misconceptions were continuing (n=3). For example student four said which subjects in primary school and high school I still could not understand in the university.

The next question was “What kind of relationship between achievement and misconceptions is there?” 66 % of the subjects stated that as the number of misconceptions increased, achievement degreased (n=8). For example student six said that achievement and misconceptions were inversely proportional. If the number of misconceptions is high, achievement is low.

Then the researcher asked the interviewees whether they knew the place of probability in curriculum as a preservice teacher. 66 % of them said they did not know (n=8). Only 33 % of them knew the place of probability in curriculum (n=4). The researcher told the subjects the place of probability and then she asked whether the time for probability in curriculum was enough or not. 50 % of the subjects thought that time for probability was not enough (n=6). For example, student eight said that it was a very extensive subject. Student seven said that child comes to High school as a blank sheet. More time should be given for probability. Only 8 % of the subjects thought that time for probability was enough (n=1).

Then the researcher wanted the subjects to think themselves as inservice teacher and to explain how they would teach probability. The interviewees talked about many different points which were shown in Table 4.23 with their percentages.

Table 4.23 How would Interviewees Teach Probability?

| How to Teach | % (n) |
|---|---|
| Material Used | 50 (6) |
| Preparation before Teaching | 42 (5) |
| Different Methods | 42 (5) |
| Basic Concepts | 33 (4) |
| Daily Examples | 33 (4) |
| From easier to complex | 25 (3) |
| Teaching without Formulation | 25 (3) |
| Language Used | 16 (2) |
| Student Centered | 16 (2) |

50 % of the interviewees talked about the importance of material used in teaching probability. Students one, two, six, eight, nine, and twelve said that they would use solid materials in teaching probability. For example student one said he believed that teaching by putting marbles and small papers in a bag was more useful. 42 % of the interviewees thought that before teaching probability, they had to study the subject. For example student three said "First I would learn and then teach. I really had lack of knowledge about probability." 42 % of the interviewees thought using different methods was important. Student two and twelve said they would use problem solving and student four said he would use discussion method. 33 % of the

interviewees emphasized the importance of using daily examples. For example, student four said “I will start from the daily life of students. For example football is a subject that boys are interested in. So they will see that probability can be used in everyday life. 33 % of the interviewees mentioned about the importance of basic concepts. Student seven said “Basic concepts at first. I will give the main concepts and explain basic points, and then I will pass to more complex questions.” Not only student seven but also 25 % of the interviewees emphasized the necessity of advancing from easier to complex. 25 % of the interviewees believed that teaching without formulation was important. For example, student four said “Giving formulation directly does not work. Formulas only helps in simple examples, not good for complex examples because logic behind probability can not be understood with direct formulization. 16 % of them mentioned about the language used while teaching probability. Student two said “The expressions used in classroom must be chosen from student’s environment. It is not logical to say gambling cards or dice to primary students. To use familiar expressions like marbles will be better.” 16 % of them mentioned the importance of student centered education. For example, student six said “I will want my students to participate by finding examples.”

The next question was “What do you think about teaching probability?” 33 % of the interviewees thought that teaching probability was very difficult (n=4) and 16 % of them did not like the subject. 33 % of them of mentioned about their insufficiency so the said they had to study before teaching (n=4) and 8 % of them was afraid of teaching (n=1), 8 % of them got accepted to teach (n=1) and 8 % of them preferred not to teach (n=1). 25 % of the interviewees wanted to teach probability (n=3) and 8 % of them believed it was an important subject to teach (n=1).

Then the interviewees were asked which ones had more effect on their attitudes toward probability teaching: students’ or teacher’s misconceptions, students’ or teacher’s achievement, students’ or teacher’s attitude toward probability? The answers were shown in Table4.24.

Table 4.24 Factors effecting teachers' attitude toward probability teaching.

| | Teacher %(n) | Student % (n) | Both % (n) |
|---|---|---|---|
| Misconceptions | 25 (3) | 16 (2) | - |
| Achievement | 16 (2) | 33 (4) | 25 (3) |
| Attitude toward Probability | 8 (1) | 42 (5) | 25 (3) |

25 % of the interviewees thought that teacher's misconceptions had more affect on their attitudes toward probability teaching, 16 % of them thought students' misconceptions would be more affective and nobody thought both students' and teacher's misconception at the same time had an affect on their attitude toward probability teaching.

16 % of the interviewees believed teacher's achievement on probability had an effect while 33 % of them thought students' achievement on their attitude toward probability teaching. 25 % of them thought both students' and teacher's achievement on probability had an effect on their attitude toward probability teaching.

8 % of the interviewees thought teacher's attitude toward probability had an effect while 42 % of them believed students' attitude toward probability had an effect on their attitude toward probability teaching. 25 % of the subjects thought both teacher's and students' attitudes toward probability had an affect on their attitude toward probability teaching.

The last question was "Does gender have an effect on probability achievement?" the percentages were shown in Table 4.25.

Table4.25 Gender Effect on Probability Achievement

| Effect %(n) | No Effect %(n) |
|---|---|
| 33 (4) | 67 (8) |

Only 33 % of the interviewees thought that gender had an effect on probability achievement. For example student four said "Females think detailer. So females are more successful." Student ten said "Males can be more successful because they can see relationships easier and in probability there are events that need to see relationships". 67 % of the subjects thought that gender had no effect on probability achievement. Student two said "I am sure when the same education is given, everybody can understand with respect to their ability." Student twelve said "I do not believe. Probability is related with logic and logic is not affected by gender."

# CHAPTER 5

# DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In this chapter the results of this study will be discussed; conclusion and some recommendations will be stated.

## 5.1 Discussion

The main purpose of this study was to investigate the factors affecting preservice mathematics teachers' decisions on probability teaching. The sub problems related with the main problem were:

- How well can attitudes toward probability teaching are explained in terms of gender, probability achievement, and attitudes toward probability?
- What are the preservice mathematics teachers' misconceptions?
- How do preservice mathematics teachers' experiences on probability affect their view about teaching probability

The subjects were given PAT, PMT, APTS, and APS respectively. Then according to the scores they got from APTS, 12 subjects were interviewed.

Many researchers have suggested that students come to teacher education programs with previously constructed knowledge, beliefs, and values which may be a help or a hindrance in learning new ideas (Adler, 1991; Britzman, 1986). This result could be valid for the present study because according to the results of the interview, almost all subjects had familiarity with probability before university Although most of the subjects complained about the probability education before university and said that they had difficulty in learning probability, nearly half of the subjects had a positive attitude toward probability which could positively effected them learning probability during their university education.

At university, mostly all the subjects complained about how probability was thought. They found probability education insufficient for teaching in schools. For example, student two said more visualization should take part in probability lessons and added it was thought in a very abstract way; student nine said he did not understand why he learnt probability and complained about using very much formulas. Also in their study, Garfield and Ahlegen (1988) found that students developed distaste for probability because it was thought in a highly abstract and formal way.

The results of the interview also showed that the experience preservice mathematics teachers had with probability during university could have an effect on their decisions about teaching probability. This result was supported by Professional Standards for Teaching Mathematics, which stated that teachers were influenced by the teaching they see and experience (NCTM, 1991). In other words, teachers' own experiences had a profound impact of their knowledge of, beliefs about, and attitudes toward mathematics, and teaching which implied great importance for student teachers' experiences in teacher education programs.

A closer look at probability course experience at university alone was quite revealing. Many subjects met with probability in statistics and probability lesson, some subjects were thought probability only in mathematics course and only a small amount of subjects met with probability in development of instructional material. For example, student six complained about monotony of probability lessons and added that both at lycee and university they did the same things. Only less than half of the subjects did study about probability and they found it insufficient. And many of them did not do any study about probability. It could be said that they possessed an insufficient level of understanding necessary for probability teaching. As a result, most of the subjects thought they were insufficient about teaching probability and some were afraid to teach probability, some thought teaching probability was hard and only a few of them believed that probability was an important subject. These results were consistent with the evidence indicating that preservice mathematics teachers possessed an insufficient level of conceptual understanding for teaching mathematics (Brown, Cooney & Jones, 1990; Post, Hare, Behr & Lesh, 1991).

That the experience preservice teachers had during learning of probability could have an affect on their decisions about teaching probability .was consistent with the regression results of the analysis in which we deduced that preservice mathematics teachers' attitude toward probability had a significant effect on their attitude toward probability teaching. According to the regression equation, attitude toward probability accounted for 54.8 % of the variance in their attitude toward probability teaching.

Although gender and probability achievement of the subjects were excluded from the regression equation, which means that gender and probability achievement had no significant affect on probability teaching, most of the subjects said their attitudes toward probability were affected by probability achievement. For example student two said that to be successful motivated him positively. Also some of them thought that their achievement would affect their attitude toward probability teaching whereas some said that students' achievement would affect their attitude toward probability teaching. And some other subjects believed both students' and their achievement would affect their decision on teaching probability. So it could be concluded as both their achievement and students' achievement could affect their attitude toward probability teaching.

Beside probability achievement, gender was the other independent variable that was excluded from the regression equation. Many subjects thought that gender had no effect on probability achievement. They also thought that their achievement could affect their attitude toward probability teaching. So it could be said that gender would not affect their attitude toward probability teaching.

Another factor that could affect probability teaching of preservice mathematics teachers is misconceptions. From the interview results, it could be seen that many subjects thought teacher was the main reason for the occurrence of misconceptions. For example, student seven said teacher should think in detail then should reflect it to students and added that when something was missing it was very hard to fill the gaps. Fortunately, being aware of teachers' important role in the occurrence of misconceptions, most of the subjects were aware of their own misconceptions and many of them believed they had always misconceptions. As an example, student four said “The topics about probability in primary school and lycee I could not understand did not change in university. I still could not understand them.”

Consistent with the interview results, from the results misconception test we used, it could be seen that both males and females had misconceptions in simple and compound events, sample size, conjunction fallacy, and effect of time axis. Only females had a high amount of misconception in equiprobability bias. This result was consistent with the results of the study conducted by Yıldız and Bulut (2002). In their study they used a 26 item misconception test and found that preservice mathematics teachers had misconceptions. In his study, Mut (2003) studied with students grade levels from 5 to 10. He found that females had equiprobability bias misconception more frequent than males. In his study, he also concluded that the frequencies of all misconception types varied across grade levels, the percentages of students who received instruction on probability in the school were higher than those who did not received instruction in terms of misconceptions on Effect of Sample Size and Time Axis Fallacy and the other misconception types were more frequent among students who did not receive a certain instruction on probability than the students who received a certain instruction probability before his study.

Also from the interview results, it could be seen that some of the subjects thought that teachers’ misconceptions were the important factor that could affect their attitude toward probability teaching and a few of them thought students’ misconceptions would affect their attitude toward probability.

The results of this study showed that the experience preservice mathematics teachers had with probability before and during the university education has a direct affect on their decisions about teaching probability.

Another result that could be reached from the interview was related with preservice teachers’ decisions on how to teach probability as inservice teachers. The interviewees were asked to think themselves as inservice teachers and explain how they would teach probability. Half of the subjects mentioned about the importance of material used. They said that they would use solid materials in teaching probability. Consistent with preservice mathematics teachers’ plans about teaching probability, in their studies, Fennal (1982) advised using newspapers, Show (1984) advised using spinners, Bruni and Silverman (1986) mentioned about using wooden or plastic cubes or different kinds of beans, and also Bright (1989) advised using simulations of rolling dice, flipping coins, or spinning a wheel.

In the interview, some subjects also talked about using different methods would be helpful for teaching probability. Lappan and Winter (1980) pointed out that teaching through concrete experiments held much more promise than teaching through traditional methods.

Some subjects at the present study emphasized the importance of using daily life examples. They also thought teaching probability without formulas would be better. Some of them mentioned the importance of student centered education. This may supported by Burns (1983). He suggested that probability concepts should be included in elementary mathematics instruction by using student centered classroom activities.

As a result it could be said that although preservice mathematics teachers complained about insufficient level of understanding conceptual knowledge of probability for teaching, they seemed to have different plans to teach probability effectively.

As a summary, there are some factors affecting preservice mathematics teachers' decisions on probability teaching. These factors were preservice mathematics teachers' attitude toward probability, probability achievement, and misconceptions. They believed that gender would have no affect on their decision on probability teaching. They had different plans of teaching probability.

### 5.2 Conclusion

In the light of above findings obtained, the following conclusions could be stated:

- Mostly all of the subjects had familiarity with probability before university.
- Mostly half of the subjects had a positive attitude toward probability before university.

- At university, mostly all the subjects complained about how probability was thought.
- Preservice mathematics teachers found probability education insufficient for teaching in university.
- Experience preservice mathematics teachers had with probability during university could have an effect on their decisions about teaching probability.
- Many subjects met with probability in statistics and probability lesson.
- Some subjects were thought probability only in mathematics course.
- Only a small amount of subjects met with probability in development of instructional material.
- It could be said that they possessed an insufficient level of understanding necessary for probability teaching.
- Mathematics teachers' attitude toward probability has a significant effect on their attitude toward probability teaching.
- Both preservice mathematics teachers' achievement and students' achievement could affect their attitude toward probability teaching.
- Gender would not affect their attitude toward probability teaching.
- Many subjects thought that teacher was the main reason for misconception to occur.
- Both males and females had misconceptions in simple and compound events, sample size, conjunction fallacy, and effect of time axis.
- Only females had a high amount of misconception in equiprobability bias.
- Some of the subjects thought that teachers' misconceptions were the important factor that could affect their attitude toward probability teaching.
- The experience preservice mathematics teachers have with probability before and during the university education has a direct affect on their decisions about teaching probability.
- They seemed to have different plans to teach probability effectively.

### 5.3 Recommendations

In this section some recommendations for teacher education and for further studies will be given.

#### 5.3.1 Recommendations for Teacher Education

Teacher educators should take time to consider the following suggestions for improving the competence of preservice mathematics teachers on probability and instruction on probability:

- Be aware of preservice teachers needs related to probability teaching as a inservice teacher.
- Provide various opportunity for using instructional materials and techniques.
- Provide them with alternative models for teaching/learning probability
- Connect advanced probability content knowledge learnt in university with the knowledge needed for classroom.
- Add probability courses on how to teach probability affectively.
- Give opportunities to preservice mathematics teachers to study with how probability can be thought in material production lessons.
- Help them integrate their probability knowledge into instructional practice.
- Satisfy them not only by teaching how to carry out probabilistic procedure but also make them understand the logic behind probability.
- Probe for potential misconceptions in preservice mathematics teachers by using carefully chosen examples in order to make them meaningful.
- Lead them gain experience about conflicts between their own intuitions and particular types of thinking in stochastic situations.

### 5.3.2 Recommendations for Further Research

This subject requires more detailed researchers. First of all the sample size must be increased in further studies. To be able to talk about Turkey overall, subjects from different geographical regions should be selected. To have more detailed opinion about preservice teachers' decisions on probability teaching, the investigation process should be laid in time i.e. from the first class of university to the fourth class.

Also a larger sample of interviewees should be used. This would increase the validity of the responses. By doing this, the research will provide more accurate information.

The present study contributes to find the factors effecting preservice mathematics teachers' decisions on probability teaching. Further researches are needed to continue the investigation.

# REFERENCES

Barnett, V. (1988). Statistical Consultancy-A basis for teaching and research. In R. Davidson, & J. Swift (Eds.)., *The proceedings of the second International Conference on Teaching Statistic*. Victoria B.C.: University of Victoria

Bar-On, E. and Or-Bach, R. (1988). Programming Math: A new Approach in Introducing Probability to Less Able Pupils, *Journal of Mathematics Education Science Technology* 19(2), 281-297.

Barz, T.J. (1970). A study of to ways of presenting probability and statistics at the college level. *Unpublished doctoral dissertation*, Columbia University

Begg, A. & Edwards, R. Teachers Ideas About Teaching Statistics. University of Waikato, New Zeland.

Beyth-Maron, R., and Dekel, S. (1983). A curriculum to improve thinking under uncertainty. *Instructional Science,* 12, 67-82.

Bright, G. W., 1989. Probability Simulations. *Arithmetic Teacher*, 36, 9, pp.16-18.

Bruni, J.V. and Silverman, H.J., 1986. Developing Concepts in Probability and Statistics- and Much More. *Arithmetic Teacher*, 30, 6, pp.34-37.

Bulut, S. (1994). The Effects of Different Teaching Methods and Gender on Probability Achievement and Attitudes toward Probability. *Unpublished Doctoral Dissertation, Middle East Technical University*, Ankara.

Bulut, S. and Ersoy, Y. (1993). An Investigation on Prospective Mathematics Teachers' Attitude Toward Probability: Abstract of ICME-7, Quebec, Canada/ Unpublished Research Report.

Bulut, S., Yetkin, İ.E. & Kazak, S. (2002). Matematik Öğretmen Adaylarını Olasılık Başarısı, Olasılık ve Matematiğe Yönelik Tutumlarının Cinsiyete Göre İncelenmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 22, 21-28.

Burns, M. Put Some Probability in Your Classroom, *Arithmetic Teacher*, 30, 7, pp-21-22.

Cankoy, O. (1989). Difference between Traditional Method and Mathematics Instruction in terms of Achievement Related to a Probability Unit. *Unpublished Master Thesis, Middle East Technical University*, Ankara.

Carpenter, T.P., Corbitt, M.K., Kepner, H.S., Linquist, M.M. and Reys, E.R.,(1981). What are the Chances of your Students Knowing Probability? *Mathematics Teacher*, 73, 342-344.

Champagne, A., Klopfer, L., & Gunstone, R. (1982). Cognitive research and the design of science instruction. *Educational Psychologist*, 17, 31-53.

Cobb, G. (1991). Teaching Statistics: More Data, Less Lecturing, *Amstat News*, 182(1), 4.

Cobb, G. (1993). Reconsidering Statistics Education: A National Science Foundation Conference, *Journal of Statistics Education* [Online], 1(1). (www.amstat.org/publications/jse/v1n1/cobb.html)

delMas, R.C., & Bart, W.M. (1987). The role of an evaluation exercise in the resolution of misconceptions of probability. *Paper presented at the Annual meeting of the American Educational Research Association.*

delMas, R.C., & Bart, W.M. (1989). The role of an evaluation exercise in the resolution of misconceptions of probability. *Focus on Learning Problems in Mathematics*, 11, 3, 39-53.

Department of Education and Science and the Welsh Office (1991). National Curriculum: Mathematics for Ages 5 to16, in G.A.Jones, C.AThornton, Langrall, C.W. & Mogill, T.A. (1996). Using Children Probabilistic Thinking to Inform Instruction, Proceeding, PME 20, Valenca, 3, 137-144.

Dusek, J.B. and Hill, K.T. (1970). Probability Learning as a Function of Sex of the Subject, Test Anxiety, and Percentage of Reinforcement. *Developmental Psychology*,3(2),195-207.

Falk, R. (1988). Conditional probabilities: Insides and difficulties. In R. Davidson, & J. Swift (Eds.)., *The Proceedings of the Second International Conference on Teaching Statistics.* Victoria, B.C: University of Victoria.

Fennel, S., 1982. The Newspaper: A Source for Applications in Mathematics. *Arithmetic Teacher*, 30, 2, pp. 22-26.

Fischbein, E. (1975) The Intuitive Sources of Probabilistic Thinking in Children. Dortrecht, The Netherlands: Reidel.

Fischbein, E. (1987) Intuition in Science and Mathematics. Dortrecht, The Netherlands: Reidel.

Fischbein, E., & Gazit, A. (1984). Does the teaching of probability improve probabilistic intuitions? Educational Studies in Mathematics, 15, 1-24.

Fischbein, E., Nello, M.S. & Marino, M.S. (1991). Factors Affecting Probabilistic Judgment in Children and Adolescents. *Educational Studies in Mathematics*, 22, 523-549.

Fischbein, E., & Schnarch, D. (1997). The Evolution with Age of Probabilistic, Intuitively Based Misconception, *Educational Studies in Mathematics*, 29, 97-105

Garfield, J.B. (1988). Obstacles to effective teaching of probability and statistics. *Paper presented at the Research Presession of the National Council of Teachers of Mathematics 66th Annual Meeting,* Chicago.

Garfield, J. & Ahlegren, A. (1988). Difficulties in Learning Basic Concepts in Probability and Statistic: Implication for Research, *Journal for Research in Mathematics Education,* 19(1), 44-63.

Garfield, J. & Ahlegren, A. (1988a). Difficulties in Learning Basic Concepts in Probability and Statistic: Implication for Research, *Journal for Research in Mathematics Education,* 19, 44-63.

Garfield, J. & Ahlegren, A. (1988b). Difficulties in Learning Basic Concepts in Probability and Statistic: In R. Davidson & J. Swift (Eds.), *The Proceedings of the Second International Conference on Teaching Statistics*. Victoria B.C: University of Victoria.

Green, D. R. (1979). The Chance and Probability Concepts Projects. *Teaching Statistics*, 1(3), 66-71.

Green, D. R. (1982). Probability Concepts in 11-16 Year Old Pupils, Loughborough University, UK: Centre for Advancement of Mathematical Education in Technology, 40 p.

Green, D. R. (1983a). A Survey of Probability Concepts in 3000 Pupils aged 11-16 years. In D.R. Grey, P. Holmes, V. Barnett, & G.M Consitable (Eds.), *Proceedings of the First International Conference on Teaching Statistics*, 766-783. Sheffield, UK: Teaching Statistics Trust.

Green, D. R. (1983b). School Pupils' Probability Concepts. Teaching Statistics, 5(2), 34-42.

Green, D. R. (1987). Probability Concept. Putting Research into Practice. *Teaching Statistics*, 9(1), 8-14.

Green, D. R. (1988). Children's understandings of Randomness: Report of survey of 1600 children aged 7-11 years. In R. Davidson & J. Swift (Eds.), *The Proceedings of the Seconds International Conference on Teaching Statistics.* Victoria, B.C: University of Victoria.

Halpern, N. (1987). Teaching Probability-Some Legal Applications. *Mathematics Teacher*, 80,150,153.

Halpern, D. (1996). Thought and Knowledge (3rd ed.), Mahwah, NJ: Lawrence Erlbaum Associates.

Hana, G., (1986). Sex Differences in the Mathematics Achievement of 8$^{th}$ Graders in Ontario. *Journal of Research in Mathematiccs Education*, 17,231-237.

Hawkins, A., & Kapadia, R.(1984). Children's conceptions of probability: A psychological and pedagogical review. *Educational Studies in Mathematics,* 15, 349-377

Hogg, R.V. (1992) Towards Lean and Lively Courses in Statistics, in *Statistics for the Twenty-First Century*, *MAA Notes* Number 26, eds. F. Gordon and S. Gordon, Washington D.C.: The Mathematics Association of America, 3-13.

Hope, J.A. & Kelly, I.W. (1983). Common Difficulties with Probabilistic Reasoning. *Mathematics Teacher*, 76, 565-570.

Jones, G.A., Langrall, C.W., Thornton, C.A. & Mogill, A.T. (1997) A framework For Assesing and Nurturing Young Children's Thinking in Probability. *Educational Studies in Mathematics, 32, 101-125.*

Jones, G.A., Langrall, C.W., Thornton, C.A. & Mogill, A.T. (1999). Students' Probabilistic Thinking in Instruction. Journal for Research in Mathematics Education, 30(5), 487-519.

Kahneman, D., Slovic, P., & Tversky, A. (1982). Judgment under uncertainty: Heuristics and biases. Cambridge: *Cambridge University Press.*

Kapadia, R. (1985). A brief survey of research on probabilistic notions. In A. Bell, B. Low, & J. Kilpatrick (Eds.), *Theory, research and practice in mathematical education* 261-265. Nottingham, UK: Shell Center for Mathematical Education.

Kimball, M.M. (1989). A new perspective on women's math achievement. *Psychological Bulletin*, 105,2,198-214.

Koirala, H.P. (1996). Preservice Teachers' use of Everyday experiences in solving probability problems. Presented at the Annual Meeting of American Educational Research Association, New York City.

Konold, C. (1983). Conceptions about probability: Reality between a rock and a hard place. (Doctoral dissertation, University of Massachusetts,1983). *Dissertation Abstracts International,* 43, 4179B.

Konold, C. (1989). Informal Conception of Probability, *Cognition and Instruction,* 6(1), 59-98.

Konold, C. (1991). Understanding students' beliefs about probability. In E.von Glasersfelt (Ed.), *Radical Constructivism in Mathematics Education*, 139-156. Holland: Kluwer.

Konold, C., Pollatsek, A., Well, A., Lohmeier, J., Libson, A. (1993). Inconsistencies in Students' Reasoning about Probability. *Journal for Research in Mathematics Education*, 24(5), 392-414.

Kreitler, S., Zigler, E. & Kreitler, H. (1983). The effects of Memory and Abstractive Integration on Children's Probability Learning. *Child Development*, 54,1487-1496.

Lappan, G. and Winter, M.J., 1980. Probability Simulations in Middle School. *Mathematics Teacher*, 83, pp-446-449.

Leder, G.C. (1992). Mathematics and gender: Changing perspectives. In D.A. Grouws (Ed.), *Handbook of Research on Mathematics Education* (pp. 597-622). New York: Macmillan.

Lee, Hea-Jin, 1999. ED433219. ERIC Clearinghouse for Science Mathematics and Environmental Education Colombus OH.

Levi, L. (2000). Gender equity in mathematics education. *Teaching Children Mathematics*, 7,2,101.

Marshall, S.p.(1984). Sex differences in children's mathematics achievement: Solving computations and story problems. *Journal of Educational Psychology*, 76,2,194-204.

McDermott, L. (1984). Research on conceptual understanding of physics. *Physics Today*, 37, 24-32.

Mestre, J. (1987, Summer). Why should mathematics and science teachers be interested in cognitive research findings? *Academic Connections*, pp. 3-5, 8-11. New York: The College Board.

Morran, J. D. and McCullars, J.C. (19799). Reward and Number Choices in Children's Probability Learning: an Attempt to Reconcile Conflicting Findings. *Journal of Experimental Child Psychology*, 27,575-596.

Mosteller, F. (1967). What has happened to Probability in the High School? *Mathematics Teacher*, 60, 824-831.

Mut, A.İ. (2004). Investigation of students' misconceptions. *Unpublished Master Thesis, Middle East Technical University*, Ankara.

National Council of Teachers of Mathematics (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, Va.: NCTM.

National Research Council (1989). *Everybody Counts. Washington, D.C.: National Academy Press.*

Obremski, T.E. (1981).The statistics odds room. In A.P. Shulte (Ed.), *Teaching Statistics and Probability*. Reston, VA: National Council of Teachers of Mathematics.

Pfannkuch, M., and Brown, M.C. (1996). Building on and Challenging Students' Intuitions about Probability: Can we improve undergraduate learning? Journal of Statistics Education, 4(1).

Piaget, J., & Inhelder, B. (1951). La Genesse de l'Idėe de Hazard chez l'Enfant. Paris: Presse Universitaire de France.

Piaget, J., & Inhelder, B. (1975). The origin of the idea of chance in children. London: Routledge & Kegan Paul.

Resnick,L.R. (1983) Mathematics and science learning: A new conception. *Science*, 220, 477-478

Roberts, H. V. (1992). Student-Conducted Projects in Introductory Statistics Courses, in Statistics for the Twenty-First Century, MAA Notes, (Number 26), eds. F. Gordon and S. Gordon. Washington D.C.: The Mathematical Association of America, 109-121.

Scheaffer, R. L. (1992). Data, Discernment and Decisions: An Empirical Approach to Introductory Statistic, in *Statistics for the Twenty-First Century*, MAA Notes (Number 26), eds. F. Gordon and S. Gordon, Washington D.C.: The Mathematics Association of America, 69-82.

Scholz, R.W., & Bentrup, A. (1984). Reconsidering the base rate fallacy: New data and conceptual issues. ( The Stochastic Thinking Project Report No. 1). Bielefeld, FRG: University of Bielefeld.

Sgoustas-Emch, S.A. & Johnson, C.J. (1998). Is Journal writing an effective method of reducing anxiety towards statistics? *Journal of Instructional Psychology*, 25, 49-57.

Shaughnessy, J.M. (1977). Misconceptions of Probability: An experiment with a small group, actively based, model building approach to introductory probability at the college level. *Educational Studies in Mathematics*, 8, 285-316.

Shaughnessy, J.M. (1992). Research in Probability and Statistics: Reflections and Directions. In D.A. Grouws (1992). *Handbook of Research on Mathematics Teaching and Learning,* 465-494. New York: Macmillan Publishing Com

Snell, J. L. (1992). CHANCE: Case Studies of Current Chance Issues, in *Statistics for the Twenty-First Century*, MAA Notes (Number 26), eds. F. Gordon and S. Gordon, Washington D.C.: The Mathematical Association of America, 281-297.

Snell, J. L. (1994). Take a Chance on CHANCE, [Online]. (www.dartmouth.edu/~chance/course/Articles/ume.html)

Thompson, A.G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning:* A project of the NCTM (pp.127-146). New York: Macmillian.

Tversky, A., & Kahneman, D. (1974). Judgments under uncertainty: Heuristics and biases. *Science*, 185, 1124-1131.

Yıldız, B.T.,& Bulut, S. (2002). Orta Öğretim Matematik Öğretmen Adaylarının Olasılıkla İlgili Kavram Yanılgılarının İncelenmesi. *V. Ulusal Fen Bilimleri ve Matematik Eğitim Kongresi, Ankara*, 256.

# APPENDIX A

## OLASILIK BAŞARI TESTİ

**Yönerge**: 1. Lütfen testin üstüne **hiç bir şey yazmayınız.**
2. Testte toplam **26** soru vardır. Soruları dikkatlice okuyunuz ve **cevap kağıdında *uygun* yere** çözünüz.

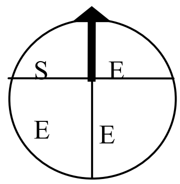
İYİ ŞANSLAR!

=============================================================

1. "DÜNYA" kelimesinden bir harf rasgele seçilmiştir. Bu deneyin mümkün olan bütün çıkanlarını listeleyiniz.
2. "UZAY" kelimesinden bir harf rasgele seçilmiştir. Sesli harfleri seçme olayının mümkün olan bütün çıkanlarını listeleyiniz.
3. "OLASILIK" kelimesinden bir harf rasgele seçilmiştir. Bu deneyin mümkün olan toplam çıkan sayısı nedir?
4. Elinizde bir çark ve hilesiz bir bozuk para var. Çark eşit olarak iki parçaya ayrılmıştır. Bu parçalar **r** ve **g** olarak isimlendirilmiştir. Çarkı çevirdiğinizi ve bozuk parayı havaya attığınızı varsayarak aşağıdaki ağaç şemasını tamamlayınız. (Not: Y:Yazı, T:Tura).

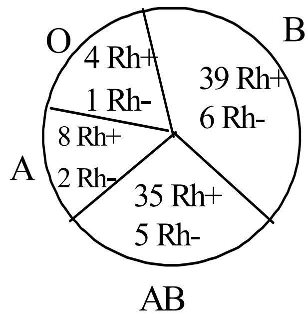
| **ÇARK** | **PARA** | **ÇIKANLAR** |
|---|---|---|
| | T | r T |
| r | ........... | ........... |
| | ........... | ........... |
| g | ........... | ........... |

5. Bir çark yanda görüldüğü gibi dört parçaya ayrılmıştır. Oku çevirdiğinizde E harfinde durma olasılığı nedir?




6. Kulüp üyelerinin her birinin ismi farklı kağıt parçalarına yazılarak bir torbanın içine konulmuştur. Bu isimler şunlardır: Kerem, Ebru, Murat, Oya ve Meral. Bir kağıt çekildikten sonra tekrar torbaya atılarak ikinci kağıt çekilmiştir. Murat ve Ebru isimlerini çekme olasılığı nedir?

7. Yandaki şekil 100 kişinin kan gruplarını ile birlikte ve Rh çeşitlerini göstermektedir. Bu 100 kişiden rasgele seçilecek olan bir kişinin AB grubundan veya Rh- olma olasılığı nedir?




8. Bir komite 3 erkek ve 2 kadından oluşmaktadır. Komite üyeleri arasından bir başkan rasgele seçilecektir. Kadın bir başkan seçilmesi olayının çıktı sayısı kaçtır?

9. 1997 yılında trafik muayenesinden geçen 630000 otomobilden 20300 tanesinin farlarının bozuk olduğu kağıda geçmiştir. Bu arabalar arasından farları bozuk olan bir arabayı rasgele seçme olasılığı nedir?

10. Bir araştırma laboratuarında 35 tane elektrikli alet üretilmiştir. Bunlardan 4 tanesi bozuktur. Onur, bu elektrikli aletlerden bir tanesini rasgele seçip test ettikten sonra Tuğba, yanlışlıkla bu aleti Onur görmeden tekrar rasgele bu aletler arasına koymuştur. Onur, ikinci kez bu aletler arasından rasgele birini seçerek test etmiştir. Seçilen her iki aletin bozuk olma olasılığı nedir?

11. Ankara'da, sarışın birini rasgele seçme olasılığı 0.4, sarışın ve yeşil gözlü seçme olasılığı 0.2, yeşil gözlü seçme olasılığı 0.3'tür. Sarışın veya yeşil gözlü birini rasgele seçme olasılığı nedir?

12. Emel'in bir matematik problemini çözme olasılığı 1/3, Cansu'nun çözme olasılığı 1/5'dir. Problemin hem Emel hem de Cansu tarafından çözülme olasılığı nedir?

13. Semra'nın kitaplığında 8 tane roman, 4 tane matematik, 3 tane kimya ve 2 tane biyoloji kitabı vardır. Semra kitaplığından rasgele bir kitap seçmek istiyor. Seçeceği kitabın roman veya matematik kitabı olma olasılığı nedir?

14. Aynı zayıflama yöntemini kullanarak zayıflamak isteyen bayanlar arasından 16 tanesi kilo kaybetmiş, 4 tanesi kilo almış, 2 tanesi ise aynen kalmıştır. Bu kişilerden biri rasgele seçildiğinde, bu kişinin kilo kaybeden bayan olma olasılığı nedir?

15. Aşağıdaki çizelge öğrencilerin aldıkları notlara göre dağılımını göstermektedir.

| Not | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Öğrenci Sayısı | 4 | 8 | 9 | 7 | 2 |

4 'ten düşük veya 3'ten yüksek not alan bir öğrenciyi seçme olasılığı nedir?

16. Bir yarışmada Erkut'un kazanma olasılığı 1/3 ve Suat'ın kazanma olasılığı ise 1/7dir. Erkut'un veya Suat'ın bu yarışı kazanma olasılığı nedir? (Not: Erkut ve Suat aynı anda kazanamaz.)

**Yönerge: Aşağıda verilen her bir olayın çeşitlerini belirleyeceksiniz. (Not: Olay çeşitleri (bağımsız, bağımlı, ayrık, ayrık olmayan, kesin, imkansız ) bir ya da birden fazla kullanıldığı gibi hiç de kullanılmayabilir.)**

17. "Gelecek yıl 29 Ekimde Cumhuriyet Bayramı olacaktır." Olayın çeşidi nedir?

18."Bir fabrikada yılda 1 milyon televizyon üretilmektedir. Bunların 5000 tanesinin arızalı olduğunu varsayınız. Test etmek için bu üretilen televizyonlardan biri seçilmiş ve test edildikten sonra tekrar rasgele televizyonlar arasına konulmuştur. Bu işlemden sonra tekrar rasgele televizyonlardan biri seçilip test edilmiştir." Olayın çeşidi nadir?

19."Bir kişi içinde "w" harfi olan bir ayda doğmuştur.".Olayın çeşidi nedir?

20. "Bir araştırmada 3 yaşında bir çocuk ya da ilkokul 5. Sınıf öğrenci olan bir çocuk seçilmek isteniyor". Olayın çeşidi nedir

21."Bir bilgisayar programı 1 ve 5 arasındaki rakamları kullanarak, seçtiği rakamı tekrar seçmeden iki basamaklı sayılar üretmektedir." Olayın çeşiti nedir

********* YÖNERGE: 22-24. soruları okuyunuz. Evet veya hayır olarak cevaplarken nedenlerini de yazınız. **************

22 Torbaya 5 pembe(p), 4 yeşil (y) ve 2 mavi (m) top konulmuştur. Torbaya bakmadan 4 tane top aynı anda çekilmektedir. {m, m, p, y, y} bu deneyin bir olayı olabilir mi? Neden?

23.5/3 bir olayın olma olasılığı olabilir mi? Neden?

24.11 tane kart şu şekilde numaralandırılmıştır: 1, 2, 4, 6, 7, 8, 9, 12, 14, 15, ve 20. Bunlar bir kutuya konulmuştur. Bunlardan 4 tanesi aynı zamanda kutuya bakılmaksızın çekilmiştir. {7'nin karesi} bu deneyin bir örnek noktası olabilir mi? Neden?

********** YÖNERGE 25-26 sorulardaki cümleleri dikkatli okuyunuz ve boşlukları uygun bir şekilde doldurunuz**. *********

25. Olasılık değerleri ............. ve ............ arasında değişmektedir.

26.2/9 olasılık oranında, "2" ........................... sayısıdır.

# APPENDIX B

## OLASILIK KAVRAM YANILGISI TESTİ

**Sevgili öğrenciler,**

Bu test sizin olasılık konusu üzerinde nasıl düşündüğünüzü ölçmek için hazırlanmıştır.Bu test sonuçları sadece araştırma amaçlı kullanılacak ve gizli tutulacaktır.Bütün soruları dikkatlice okuyup kendinize en uygun seçeneği işaretleyiniz ve altına neden o seçeneği işaretlediğinizi açıklayınız.

Adınız Soyadınız:.................................
Üniversite ismi :.................................

## SORULAR

**1)** Hilesiz bir madeni para 5 defa arka arkaya havaya atılıyor.**Y** yazıyı **T** turayı temsil ettiğine göre bu atışlarda sırasıyla aşağıdakilerden hangisinin gelme olasılığı en büyüktür?

a)**YYYTT** b)**YTTYT** c)**TYTTT**
d)**YTYTY** e)a,b,c ve d şıklarının gelme olasılıkları eşittir.

**2)**Bir sayısal loto oyununda bir kişi **1'**den **40'a** kadar olan sayılardan 6 tanesini seçmek zorundadır.Ahmet 1,2,3,4,5 ve 6 sayılarını,Nuray 39,1,17,33,8 ve 27 sayılarını seçmiştir.Sizce kimin kazanma olasılığı daha büyüktür?

a)Ahmet b)Nuray c)İkisinde kazanma olasılıkları eşittir.

**3)**Özge hilesiz bir madeni parayı üç kez havaya atmış ve hepsinde yazı gelmiştir.Özge dördüncü kez parayı havaya attığında aşağıdakilerden hangisi doğru olur?

a)Yazı gelme olasılığı,tura gelme olasılığına eşittir.
b)Yazı gelme olasılığı,tura gelme olasılığından küçüktür.
c)Yazı gelme olasılığı,tura gelme olasılığından büyüktür.

**4)**Bir baba ve oğlu her gün bir oyun oynuyorlar.Oyunda baba, eline bir madeni para alır ve ellerini arkasına saklar.Eğer çocuk paranın babasının hangi elinde olduğunu bilirse parayı kazanır.Geçen 14 gün içinde çocuk 5 defa doğru,9 defa yanlış tahminde bulunmuştur.Gelecek 14 günde aşağıdakilerden hangisinin olmasını beklersiniz?

a)Çocuğun doğru tahmin sayısının yanlış tahmin sayısından fazla olmasını.
b)Çocuğun doğru tahmin sayısının yanlış tahmin sayısından az olmasını.
c) Çocuğun doğru tahmin sayısının yanlış tahmin sayısına eşit olmasını

**5)**Hilesiz iki zar aynı anda havaya atılıyor.Aşağıdakilerden hangisinin olma olasılığı daha büyüktür?

a)6 ve 6 rakamlarının gelmesi(başka bir değişle 6-6 çiftinin gelmesi)
b)5 ve 6 rakamlarının gelmesi(başka bir değişle 5-6'nın gelmesi)
c) "a" ve "b" şıklarının olma olasılıkları eşittir.

**6)** "**ÇİÇEK**" kelimesini oluşturan harfler kağıtlara yazılıp torbaya atılıyor.Bu torbadan rasgele seçilen harfin "**Ç**" olma olasılığı aşağıdakilerden hangisidir?

a) 2/5 b) 2/3 c)1/4

**7)**Bir hastanede yeni doğanların kayıtları tutuluyor.Buna göre aşağıdakilerden hangisinin olma olasılığı daha büyüktür?

a)İlk doğan 10 bebekten 8 veya daha fazlasının kız olması.

b)ilk doğan 100 bebekten 80 veya daha fazlasının kız olması.

c)a ve b şıklarının olma olasılıkları eşittir.

**8)Olay 1:**Hilesiz bir madeni paranın 300 kez havaya atılması deneyinin sonucunda en az 200 kez yazı gelmesi.

**Olay 2:**Hilesiz bir madeni paranın 3 kez havaya atılması deneyi sonucunda en az 2 kez yazı gelmesi.

Yukarıdaki deneylerden hangisinin sonucunun olma olasılığı daha büyüktür?

a) Olay 1

b)Olay 2

c) Olay 1 ve Olay 2'nin olma olasılıkları eşittir.

**9)**Fatih insanlara yardım etmeyi sevmekte ve doktor olmayı istemektedir.Lisedeyken Kızılay kolunda görev almış ve yaz kamplarında sağlık hizmetlerinde çalışmıştır. Şu anda bir üniversiteye kayıtlıdır.Buna göre aşağıdakilerden hangisi daha olası görünmektedir?

a)Fatih Tıp Fakültesinde öğrencidir. B)Fatih öğrencidir.

**10)K:**10 kişilik bir topluluk içinden oluşturulacak 2 kişilik grupların sayısı,

**L:**10 kişilik bir topluluk içinden oluşturulacak 8 kişilik grupların sayısı,

Olduğuna göre **K** ve **L** sayıları arasında nasıl bir ilişki vardır?

a)K, L’den büyüktür.
b)K, L’den küçüktür.
c)K, L’ye eşittir.

**11)**Dilek’in elinde ,içinde iki siyah ve iki beyaz bilye bulunan bir torba var.Dilek torbadan bir bilye çekiyor ve bilyenin beyaz olduğunu görüyor.Elindeki bilyeyi geri koymadan bir bilye daha çekiyor.Buna göre aşağıdakilerden hangisi doğrudur?

a)İkinci bilyenin beyaz olma olasılığı,siyah olma olasılığına eşittir.
b)İkinci bilyenin beyaz olma olasılığı,siyah olma olasılığından büyüktür.
c)İkinci bilyenin beyaz olma olasılığı,siyah olma olasılığından küçüktür.

**12)**Ahmet’in elinde içinde iki siyah ve iki beyaz top bulunan bir torba var.Ahmet torbadan bir top çekiyor ve bakmadan topu bir kenara koyuyor.Torbadan başka bir top daha çekiyor ve bunun beyaz olduğunu görüyor.Buna göre aşağıdakilerden hangisi doğrudur?

a)İlk çektiği topun beyaz olma olasılığı,siyah olma olasılığından büyüktür.
b)İlk çektiği topun beyaz olma olasılığı, siyah olma olasılığından küçüktür.
c)İlk çektiği topun beyaz olma olasılığı,siyah olama olasılığına eşittir.

**13)**5 yüzü siyaha,1 yüzü de beyaza boyanmış 6 tane hilesiz zar atıldığında aşağıdakilerden hangisinin olma olasılığı daha büyüktür?

a)5 zarın siyah,1 zarın beyaz gelmesi.
b)6 zarın siyah gelmesi.
c) “a” ve “b” şıklarının olma olasılıkları eşittir.

# APPENDIX C

## OLASILIK ÖĞRETİMİNE KARŞI TUTUM ÖLÇEĞİ

**Sevgili öğrenciler;**

Bu anket iki bölümden oluşmaktadır: 1.Kişisel Bilgiler; 2.Matematik Öğretmen Adaylarının Olasılık Öğretimine karşı Tutum Ölçeği. Yaptığımız çalışma, sizlerin Olasılık konusunu öğretmeye yönelik tutumlarınızı belirlemek için yapılmaktadır.Ne kadar içten cevap verecek olursanız çalışmadan elde edilecek sonuçlar o kadar güvenilir olacaktır.Bu anket, sadece araştırma amacıyla kullanılacaktır ve kesinlikle gizli tutulacaktır. Yardımlarınız için teşekkürler.

**KİŞİSEL BİLGİLER:**

İsminiz: ..................

Cinsiyetiniz( )K ( )E

Üniversiteye Giriş ÖYS Puanınız:

Olasılık Başarınızı Derecelendiriniz:

( )Çok İyi ( )İyi ( )Orta ( ) Zayıf

Olasılıkla İlgili Yeteneğinizi Değerlendiriniz:

( )Çok İyi ( )İyi ( )Orta ( ) Zayıf

## MATEMATİK ÖĞRETMEN ADAYLARININ OLASILIK ÖĞRETİMİNE KARŞI TUTUM ÖLÇEĞİ

**Yönerge:**Bu ölçek Olasılık öğretimi konusunda tutum cümleleri içermektedir. Bu cümlelerin doğru ya da yanlış cevapları bulunmamaktadır. Yalnızca sizin doğru olduğunu düşündüğünüz cevaplar doğru kabul edilmektedir. Mümkün olduğunca düşüncelerinizi ve duygularınızı göz önüne alarak karar veriniz. Bu belirtmeniz için "Kesinlikle Katılıyorum", "Katılıyorum", "Kararsızım", " Katılmıyorum", "Kesinlikle Katılmıyorum" seçenekleri ile verilmiştir. Hiçbir cümlede fazla zaman kaybetmeden hızlı fakat dikkatlice okuyarak hiçbir cümleyi boş bırakmadan samimi olarak kendi durumunuza uygun olan yuvarlağı işaretleyiniz.

| | Kesinlikle Katılıyorum | Katılıyorum | Kararsızım | Katılmıyorum | Hiç Katılmıyorum |
|---|---|---|---|---|---|
| 1)Olasılık öğretmekten hoşlanırım | | | | | |
| 2)Olasılık öğretirken sabırlıyımdır. | | | | | |
| 3)Olasılık öğretmenin öğrencilerin gelecekteki hayatlarına olumlu katkısı olmaz. | | | | | |
| 4)Öğrencilerin olasılık konularından korkmamalarını sağlayabilirim. | | | | | |
| 5)Olasılık konusunu öğretmek benim için sıkıcıdır. | | | | | |
| 6)olasılık konusunu öğretmekten hiç endişe duymam. | | | | | |
| 7Olasılık konusu okullarda öğretilmese daha iyi olur. | | | | | |
| 8)Olasılık konusunu öğretirken değişik öğretim yöntemlerinden yararlanabilirim. | | | | | |
| 9)Olasılık konusunu öğretmek bana çekici gelir. | | | | | |
| 10)Olasılık konusunu öğretirken aklım karışır. | | | | | |
| 11)Olasılık konusunu etkin bir şekilde öğretmek için değişik yöntemler kullanmayı öğrenmek isterim. | | | | | |
| 12)Olasılık konusunu öğretirken çocuklara olaylara farklı açılardan bakma becerisi kazandırabilirim. | | | | | |
| 13)Olasılık konusunu öğretmek ilginçtir. | | | | | |
| 14)Olasılık konusu öğretirken kendimi çaresiz hissederim. | | | | | |
| 15)Olasılık konusunda gelişmek ve ilerlemek benim için önemlidir. | | | | | |
| 16)Öğrencilerin olasılık konusunda kendilerini yeterli hissetmelerini sağlayabilirim. | | | | | |
| 17)Olasılık konusunu öğretirken huzursuz olurum. | | | | | |
| 18)Olasılık konusunu çocuklara sevdirebilirim. | | | | | |

## APPENDIX D

## OLASILIK KONUSUNA KARŞI TUTUM ÖLÇEĞİ

**AÇIKLAMA:** Aşağıda olasılığa ilişkin tutum cümleleri ile her cümlenin karşısında "Tamamen Katılıyorum", "Katılıyorum", "Katılabilirim", "Katılmayabilirim", "Katılmıyorum" ve "Tamamen Katılmıyorum" olmak üzere altı seçenek verilmiştir. Lütfen, cümleleri dikkatle okuduktan sonra her cümle için kendinize uygun olan seçeneklerden birini işaretleyiniz.

| | | | | | | |
|---|---|---|---|---|---|---|
| 01. Olasılık konularını severim. | O | O | O | O | O | O |
| 02. Olasılık konuları sevimsizdir. | O | O | O | O | O | O |
| 03.Olasılıkla ilgili konuları tartışmaktan hoşlanırım. | O | O | O | O | O | O |
| 04.Olasılıkla ilgili bilgiler can sıkıcıdır. | O | O | O | O | O | O |
| 05. Olasılık konuları zihin gelişimine yardımcı olur. | O | O | O | O | O | O |
| 06. Olasılık konusu beni huzursuz eder. | O | O | O | O | O | O |
| 07. Olasılıkla ilgili ders saatlerinin daha çok olmasını isterim. | O | O | O | O | O | O |
| 08. Olasılık konuları rahatlıkla öğrenilebilir. | O | O | O | O | O | O |
| 09. Olasılıkla ilgili sınavlardan korkarım. | O | O | O | O | O | O |
| 10. Olasılık konuları ilgimi çeker. | O | O | O | O | O | O |
| 11. Olasılığın doğru karar vermemizde önemli bir rolü vardır. | O | O | O | O | O | O |
| 12. Olasılık konuları aklımı karıştırır. | O | O | O | O | O | O |
| 13. Olasılık konusunu severek çalışırım. | O | O | O | O | O | O |
| 14. Olasılık konusunu, elimde olsa, öğrenmek istemezdim. | O | O | O | O | O | O |
| 15. Olasılık, ilginç bir konu değildir. | O | O | O | O | O | O |
| 16. Olasılıkla ilgili ileri düzeyde bilgi edinmek isterim. | O | O | O | O | O | O |
| 17. Olasılık hemen hemen her iş alanında kullanılmaktadır. | O | O | O | O | O | O |
| 18. Olasılık konusunu çalışırken canım sıkılır. | O | O | O | O | O | O |
| 19. Olasılık, kişiye düşünmeyi öğretir. | O | O | O | O | O | O |
| 20. Olasılığın adını bile duymak sinirlerimi bozuyor. | O | O | O | O | O | O |
| 21. Olasılık konusundan korkarım. | O | O | O | O | O | O |
| 22. Olasılık herkesin öğrenmesi gereken bir konudur. | O | O | O | O | O | O |
| 23. Olasılık konusundan hoşlanmam. | O | O | O | O | O | O |
| 24. Olasılıkla ilgili bilgiler, kişinin tahmin yeteneğini artırır. | O | O | O | O | O | O |
| 25. Olasılık konusu anlatılırken sıkılırım. | O | O | O | O | O | O |
| 26. Olasılık konusu anlatılırken sıkılırım. | O | O | O | O | O | O |
| 27. Olasılık konusu okullarda öğretilmese daha iyi olur. | O | O | O | O | O | O |
| 28. Olasılık konuları, eğlencelidir. | O | O | O | O | O | O |

## APPENDIX E

## GÖRÜŞME SORULARI

Araştırmamıza katkıda bulunduğunuz için teşekkür ederim. Bu görüşme sizin izninizle kasete kaydedilecektir. Bulgular bilimsel dergilerde yayımlanmak yada bilimsel toplantılarda sunulmak üzere değerlendirilecektir. Bunun dışında herhangi bir amaçla kullanılmayacaktır. Katkılarınız için tekrar teşekkür ederim.

- Olasılık deyince aklınıza neler geliyor? Açıklar mısınız?

**Üniversite yılları öncesinde olasılık:**

- Üniversite yılları öncesinde olasılık konusu hakkında bilginiz var mıydı?
  Bu konu öğretildi mi?
  Hangi sınıflarda?
- Öğretmeninizin konu hakkında yeterliliği nasıl dı?
  Sizi nasıl etkilemişti?
- Öğretmeninizin konuya karşı tutumu nasıldı?
  Sizi nasıl etkiledi? Neden?
- Konuyu öğrenmeye karşı tutumunuz ne oldu? Neden?
- Konu nasıl işlendi?
- Ne tür kavram yanılgılarınız vardı?
- Öğrenmekte zorluk çektiniz mi? Neden?
- Olasılığa karşı tutumunuzu neler etkiledi?

**Üniversite Yıllarında Olasılık**

- Üniversitede olasılık konusu ile hangi derslerde karşılaştınız?
  Ayrı bir İstatistik-Olasılık dersi aldınız mı? Neden?
- Konuyla ilgili aldığınız eğitim öğrenme ve öğretim açısından yeterli mi?

Nasıl olmasını isterdiniz? Neden?

- Bu konu matematikten ayrı düşünülebilir mi? Neden?
- Aldığın öğretim metotları ve materyal geliştirme dersinde olasılık konusu ile ilgili çalışma yaptınız mı?

Yeterlimiydi? Neden?

Nasıl olmasını isterdiniz? Neden?

- Üniversitede aldığınız eğitim konuya karşı tutumunuzu nasıl etkiledi? Neden?
- Başarınız nasıldı? Neden?
- Başarınız konuya karşı tutumunuzu nasıl etkiledi? Neden?
- Sizce kavram yanılgıları neden oluşmakta?
- Kavram yanılgılarınız farkında mısınız?

Daha önceki kavram yanılgılarınız devam ediyor mu? Neden?

- Kavram yanılgılarınızla başarınız arasıda nasıl bir ilişki var? Neden?

**Üniversite Sonrası Öğretmen Gözüyle Olasılık**

- Üniversiteyi bitiriyorsunuz. Bir öğretmen olarak olasılık konusunu müfredattaki yeri nedir?

Hangi seviyelerde öğretiliyor?

Olasılık için ayrılan zaman yeterli mi? Neden?

Olasılık konusu hangi kavramları kapsıyor?

Olasılık ilgili içerik yeterli mi? Neden?

- Bir öğretmen olarak olasılığı nasıl öğretmeyi düşünüyorsunuz?

Öğretim tekniklerinin farkında mısınız?

- Olasılık konusunu öğretme hakkında ne düşünüyorsunuz? Neden?
- Konuyu öğretmekle ilgili tutumunuzu neler etkiler?

Öğrencilerinizin mi yoksa sizin kavram yanılgılarınız mı daha etkili?

Öğrencilerinizin mi yoksa sizin başarınız mı daha etkili?

Öğrencilerinizin olasılığa karşı tutumumu yoksa sizin tutumunuz mu daha etkili?

- Sizce cinsiyetin olasılık başarısına etkisi var mı?