INVESTIGATION OF PERFORMANCES OF PROSPECTIVE MATHEMATICS TEACHERS ON PROBABILITY

MATEMATİK ÖĞRETMEN ADAYLARININ OLASILIK PERFORMANSLARININ İNCELENMESİ

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ABSTRACT: There is a difficulty in teaching/learning the concept of probability because of the various reasons such as a shortage of competent teachers and students' misconceptions. In the study, the performances of the prospective mathematics teachers on probability was investigated. The subject consisted of 125 seniors enrolled in the secondary mathematics teacher education programs in Ankara. The percentages of correct answers of seven questions was lower than that of wrong answer. The prospective mathematics teachers did not have some basic concepts of probability such as probability of occurring event(s), sample point, and sample space. They also could not specify type of events. Furthermore, they could not compute probability of non-mutually exclusive events. Consequently, prospective mathematics teachers did not have enough competencies on probability.

KEY WORDS: *Probability, Prospective Mathematics Teacher, Performance on Probability*

ÖZET: Olasılık kavramının öğretilmesinde, öğrenilmesinde çeşitli nedenlerden dolayı zorluklar yaşanmaktadır. Bunlardan bazıları şunlardır: konusuna hakim öğretmenlerin azlığı, öğrencilerin kavram yanılgılarına sahip olması. Bu çalışmada matematik öğretmen adaylarının olasılıkla ilgili performansları incelenmiştir. Bu çalışmada yer alan 125 kişi Ankara'da bulunan ortaöğretim matematik öğretmenliği programına kayıtlı 4. sınıf öğrencisidir. Testteki 7 soruya verilen doğru cevapların yüzdesi yanlış cevaplarının yüzdesinden düşüktür. Bu soruların detaylı analizinden sonra, matematik öğretmen adaylarının bazı temel olasılık kavramlarına sahip olmadıkları ortaya çıkmıştır. Bu kavramlardan bazıları şunlardır: Bir olayın/olayların olma olasılığı, örneklem nokta ve örneklem uzaydır. Ayrıca, öğretmen adayları olayların çeşidini belirleyememiştir. Bunlardan başka, ayrık olmayan olayların olma olasılığını hesaplayamamışlardır. Sonuç olarak, matematik öğretmen adayları olasılıkla ilgili yeterli bilgiye sahip değildir.

ANAHTAR SÖZCÜKLER: Olasılık, Matematik Öğretmen Adayı, Olasılık Performansı

1. INTRODUCTION

The changes in the world economy create a greater need for mathematically literate workers than ever before. However, the traditional mathematics curriculum does not meet the needs of the emerging information society. Social change demands changes in how mathematics is taught as well as changes in what topics are taught. One topic that needs increased attention is probability. It is a very important concept used in daily life. For example, individuals are often faced with making decisions in uncertain environments and about random phenomena. Such situations often demand probabilistic reasoning, knowledge, and experiences. Moreover, probability is identified as a critical basic skill by various international organizations (e.g. UNESCO), government committees, and national mathematics teacher associations [1]. There are major reform movements in mathematics education in various countries including the United States of America and the United Kingdom [1,2]. One of the major themes of this reform includes emphasis on the inclusion of topics traditionally given little attention such as probability [1,2].

Probability was introduced as a topic in the Turkish high school mathematics curriculum in the 1960's [3]. However, it received very little attention and often was not taught at all. In the latest revision of the school mathematics curriculum in Turkey several topics on probability and statistics were included [4,5]. In

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Turkey probability concepts are taught at eighth and tenth grades [6]. However, there are still some problems related to teaching probability in the Turkish Secondary Schools [7,8,9,10]. Not only in Turkey but also in the schools of most countries all over the world there is considerable evidence that it has not been taught effectively [8,11,12,13]. There are various reasons for this, such as a shortage of competent teachers [8,11], student difficulties[12,13]. Consequently, probability is a very important concept to students but one of the problems of teaching probability is related to the qualifications of mathematics teachers. Hence, the purpose of this study is to investigate the performances of prospective mathematics teachers on probability during the university education. If their performances are not good, there will be some recommendations to improve their knowledge before they have graduated from the teacher education program.

2. METHOD

2.1. Subjects

The present study was conducted in fall semester of 1998 academic year. The subjects of the study consisted of 125 senior students in the mathematics teacher education programs in three universities in Ankara (i.e.Hacettepe University: n=41; Gazi University: n=38, and Middle East Technical University: n=46).

2.2. Instrument

The researcher developed the Probability Achievement Test (PAT). It was administered to 206 eighth grade students. The content validity

of the PAT was checked by a mathematics educator and a mathematics teacher. The alpha reliability coefficient of the PAT with 26-questions was found as 0.74 by using the ITEMAN program. The original form of this test was in English because it was used in the research conducted on 8th grade students enrolled in the private school that the medium of instruction was in English. For the present study, it was translated into Turkish to be administered to Turkish students. It was given to 112 university students. The alpha reliability coefficient of the Turkish PAT was 0.91. If the question of the PAT was answered correctly, it was scored as 1. If the answer was wrong, it was scored as 0. The total score of PAT was out of 26. In the paper, questions were given in English. To eliminate the problems caused by the translation, the questions were translated back to Turkish.

3. RESULTS

As seen in Table 1, the mean scores of PAT was 17.91, 17.29, 11.80 for METU, Gazi and Hacettepe Universities respectively (i.e. the total score of PAT was out of 26). In order to see the overall scores on this test, the percentages of PAT scores with respect to each university was given in Table 2.

In the present study we found that the percentages of correct answers of seven questions were lower than that of wrong answer. These are questions 3, 7, 8, 18, 20, 24 and 26. The success in these questions was very low (i.e. each question was out of one). These seven questions were analyzed in detail only because analyses of 26 questions would be very long.

Table 1. Descriptive Statistics of Probability Achievement Test

University	n	$\overline{X}$	SD	Mode	Median	Min-Max
METU	46	17.91	4.17	20	18.5	8-25
Gazi	38	17.29	4.00	17	17.5	4-23
Hacettepe	41	11.80	5.19	10	11	3-22
Total	125	15.72	5.23	17	17	3 – 25

Table 2. Percentages of PAT Scores with respect to the Universities (%)

Score	METU	Gazi Univ.	Hacettepe Univ.	Total
3	-	-	2	1
4	-	3	2	2
5	-	3	12	5
6	-	-	2	1
7	-	-	2	1
8	2	-	7	3
9	-	-	5	2
10	2	-	14	6
11	7	-	5	4
12	2	-	2	2
13	4	5	5	5
14	-	3	7	3
15	11	11	-	7
16	9	8	7	8
17	7	18	5	10
18	7	8	10	8
19	4	16	5	8
20	17	8	-	9
21	7	8	2	6
22	10	5	2	6
23	2	5	-	2
24	7	-	-	2
25	2	-	-	1

The analyses of seven questions are given in the following sections (Note: 1. Questions were translated from Turkish. into English in this paper; 2. C_T represents correct answer given by all prospective mathematics teachers in the present study. W_T represents wrong answer given by all prospective mathematics teachers of the study.).

Question 3:

Each letter from the word "OLASILIK" is written on a piece of paper. The papers are put into the bag and mixed up and then one is drawn. How many possible outcomes are there in this experiment?($C_T\%=19$; $W_T\%=81$)

As seen in Table 3, most of the prospective mathematics teachers thought that universal set and sample space were the same. Its reason can be that their mathematics teachers could not
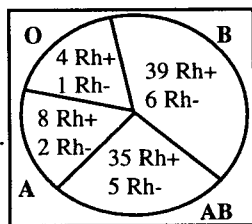
Table 3. Analysis of Question 3 in the Probability Achievement Test

University	Number of Sample Space=8 (Correct Answer)	Number of Universal Set=6	Listing of Universal Set {O,L,A,S,I,K}	Computation of Probability	Other Answers	No Answer
METU	6 (13%)	17 (37%)	7 (15%)	7 (15%)	4 (9%)	5 (11%)
Gazi	13 (34%)	12 (32%)	2 (5%)	4 (11%)	4 (11%)	3 (8%)
Hacettepe	5 (12%)	15 (37%)	1 (2%)	-	13 (32%)	7 (17%)
Total	24 (19%)	44 (35%)	10 (8%)	11 (9%)	21 (17%)	15 (12%)

clarify the difference between sample space and universal set.

Question 7:

The figure describes the blood groups and Rh types of 100 people. When one of them is randomly selected, what is

the probability of selecting a person who has a group AB or a type Rh? $(C_T\%=30;$ $W_T\%=70)$

As seen in Table 4, most of the prospective mathematics teachers could not compute the probability of occurring events because they could not figure out whether or not the events were mutually exclusive.

outcomes of this event? $(C_T\%=29;$ $W_T\%=71)$

As seen in Table 5, most of the prospective teachers computed the probability of the occurrence of the event instead of writing the number of event because they used to compute the probability of occurring events in the mathematics courses.

Question 18:

In a factory, 1 million TV's are produced in a year. Suppose that 5000 are defective. In order to test, one of them is randomly selected. And after testing process, it was replaced into TV randomly. Then, one of them was selected randomly. What is the name of the event? $(C_T\%=28;$ $W_T\%=72)$

Table 4. Analysis of Question 7 in the Probability Achievement Test

University	Probability of the Occurrence of Non-Mutually Exclusive Events=49/100 (Correct Answer)	Probability of the Occurrence of Mutually Exclusive Events=54/100	Probability of the Occurrence of Independent Events	Other Answers	No Answer
METU	18 (39%)	14 (30%)	1 (2%)	12 (26%)	1 (2%)
Gazi	14 (37%)	12 (32%)	1 (3%)	9 (24%)	2 (5%)
Hacettepe	5 (12%)	15 (37%)	-	11 (27%)	10 (24%)
Total	37 (30%)	41 (33%)	2 (2%)	32 (26%)	13 (10%)

Table 5. Analysis of Question 8 in the Probability Achievement Test

University	Number of Event: 2 (Correct Answer)	Computation of Probability of Occurrence of Event= 2/5	Other Answers	No Answer
METU	22 (48%)	19 (41%)	4 (9%)	1 (2%)
Gazi	12 (32%)	18 (47%)	6 (16%)	2 (5%)
Hacettepe	1 (2%)	19 (46%)	17 (42%)	4 (10%)
Total	35 (28%)	56 (45%)	27 (22%)	7 (6%)

Question 8:

A committee consists of 3 men and 2 women. A chairman is chosen at random among the committee members. If the event is "selecting a woman", what is the number of

As seen in Table 6, most of the prospective mathematics teachers confused dependent and independent events in the 18th question because they could not understand the types of events very well.

Table 6. Analysis of Question 18 in the Probability Achievement Test

University	Independent Events (Correct Answer)	Mutually Exclusive Events	Dependent Events	Non-Mutually Exclusive Events	Two Types of Events	No Answer
METU	15 (33%)	5 (11%)	16 (35%)	2 (5%)	3 (7%)	5 (11%)
Gazi	16 (42%)	2 (5%)	6 (16%)	4 (11%)	2 (5%)	8 (21%)
Hacettepe	3 (7%)	1 (2%)	9 (22%)	3 (7%)	3 (7%)	22 (54%)
Total	34 (27%)	8 (6%)	31 (25%)	9 (7%)	8 (6%)	35 (28%)

Question 20:

In one research, we want to select a child who is 3 years old age or a child who is in the 5th grade. What is the name of event? ($C_T\%=35$; $W_T\%=65$)

As seen in Table 7, most of the prospective mathematics teachers confused the mutually exclusive events and independent events in the 20th question because of the same reason stated for question 18.

Question 24:

Eleven cards are numbered as 1,2,4,6,7,8,9,12,14,15, and 20. They are put into a box. Then four cards are taken at the same time. is { square of 7} a sample point of this experiment? ($C_T\%=40$; $W_T\%=60$)

As seen in Table 8, most of the prospective mathematics teachers could not answer the question 24 because they did not have the

Table 7. Analysis of Question 20 in the Probability Achievement Test

University	Mutually Exclusive Events (Correct Answer)	Independent Events	Non-Mutually Exclusive Events	Dependent Events	Two Types of Events	No Answer
METU	20 (44%)	13 (28%)	2 (4%)	3 (7%)	4 (9%)	4 (9%)
Gazi	11 (29%)	10 (26%)	2 (5%)	2 (5%)	4 (11%)	9 (24%)
Hacettepe	13 (32%)	8 (20%)	2 (5%)	3 (7%)	1 (2%)	14 (34%)
Total	44 (35%)	31 (25%)	6 (5%)	8 (6%)	9 (7%)	27 (22%)

As seen in Tables 6 and 7, most of the prospective mathematics teachers did not have competency on the meanings of types of events. This could probably cause the problem in the

meaning of sample point. They could forget its meaning. Some of them wrote that they did not learn it in their mathematics courses.

Table 8. Analysis of Question 24 in the Probability Achievement Test

University	Not Sample Point (Correct Answer)	Sample Point	No Answer
METU	29 (63%)	7 (15%)	10 (22%)
Gazi	7 (17%)	4 (10%)	30 (73%)
Hacettepe	28 (74%)	-	10 (26%)
Total	64 (51%)	11 (9%)	50 (40%)

computation of probability of the occurrence of the compound events.

Question 26:

In the value of probability, 2/9 , "2"

*is the number of*_____.

$(C_T \%=34; W_T\%=67)$

As seen in Table 9, most of the prospective mathematics teachers did not have the basic concept of probability. In addition, they could not realize the relationship between concepts of fraction and probability.

However, high-level probability topics were taught in detail. As a result, prospective teachers in three universities were graduated without having enough competence on probability. Hence, it is likely that they can not teach effectively when they become teachers in grades 8 or 10. This conclusion is consistent with the result of study of [8] ,which many mathematics teachers could not teach probability effectively

Table 9. Analysis of Question 26 in the Probability Achievement Test

University	Correct Answers				Incorrect Answers		
	Event	Occurrence of Events	Outcome	Expected Result	Probability	Other Answers	No Answer
METU	15 (33%)	4 (8%)	8 (17%)	4 (9%)	6 (13%)	-	9 (20%)
Gazi	7 (18%)	-	3 (8%)	2 (5%)	3 (8%)	12 (32%)	11 (29%)
Hacettepe	3 (7%)	-	2 (5%)	-	13 (32%)	-	23 (57%)
Total	25 (20%)	4 (3%)	13 (10%)	6 (5%)	22 (18%)	12 (10%)	43 (34%)

4. DISCUSSION AND RECOMMENDATION

It could be concluded that the performances of prospective mathematics teachers in the present study were not high in some basic probability concepts such as probability of occurrence of event(s), sample point, and sample space. They also did not specify the type of events. Furthermore, they could not compute the probability of non-mutually exclusive events.

In the mathematics teacher education program of the Hacettepe University there is no compulsory course on probability. The prospective mathematics teachers at the METU study probability in "Abstract Algebra" course very briefly. At the Gazi University, there is a course titled as "Probability and Statistics". Unfortunately, enough time were not spent for probability concepts taught in both 8th and 10th grades by giving the basic formula for computing the occurrence of the events.

or they did not teach anything on probability in school mathematics courses. The result of the present study is also consistent with the result of study [8]. In this study the Probability Achievement Test developed by Cankoy [14] was administered to the third year mathematics education students who were taking the course "Probability for Mathematics Teachers" at the METU. The mean of the achievement test was 61.4 out of 100. Since the test was developed for the assessment of the 8th grade students in Turkey, this low score indicates that prospective mathematics teachers had inadequate acquisition of probability concepts. According to my observations, prospective mathematics teachers had difficulties in teaching probability in the "Methods of Teaching Mathematics Courses". When I interviewed with them, they told that they could not teach probability by utilizing different teaching techniques without having any information on probability itself. After they learn probability, they should also learn how to teach probability effectively in

school mathematics courses. In order to achieve these purposes, there must be a course such as "Teaching Probability and Statistics" in the Mathematics Teacher Education Programs. It should cover "probability" including both high level concepts and concepts taught in 8th and 10th grades. In this course prospective teachers should also learn how to teach probability effectively.

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