

Gender Differences of Elementary Prospective Teachers in Mathematical Beliefs and Mathematics Teaching Anxiety

Ersen Yazıcı, Erhan Ertekin

Abstract—In this study, any possible differences between mathematics beliefs and anxiety of prospective elementary mathematics teachers have been investigated according to their gender. In this purpose, 1st, 2nd, 3rd and 4th grade students from a Government University in Turkey were selected as a sample. Mathematics Teaching Anxiety Scale (MATAS) and Beliefs About Mathematics Survey (BAMS) has been used as data collection tools. As a result of the study, it has been observed that prospective male teachers have more instrumentalist approach in learning mathematics than females according to their mathematical beliefs. On the other hand, females have more mathematics teaching anxiety than males especially, for subject knowledge in mathematics and self-confidence.

Keywords—Mathematical beliefs, mathematics teaching anxiety, gender, prospective elementary mathematics teachers.

I. INTRODUCTION

GENDER differences in learning mathematics continue to be a focus of interest [12] and the majority of studies show that there is a communal belief that males are better in mathematics [18]. It is possible to say that both personal and corporate beliefs, generated due to some genetic differences between females and males, are the underlying reasons for gender differences being handled at this level in mathematics and other fields. Furthermore, a wide range of sociocultural forces contribute to sex differences in mathematics achievement and ability – including the effects of family, neighborhood, peer, and school influences; training and experience; and cultural practices. Early experience, biological factors, educational policy, and cultural context affect the number of females and males who pursue advanced study in science and math and that these effects add and interact in complex ways. There are no single or simple answers to the complex questions about sex differences in science and mathematics [10].

The reasons for gender differences have been collected under two headings by [17], internal and external. Internal factors have been defined as biological, cognitive and affective factors. While external factors are numerous, it has

been determined that significant others and classrooms are external factors that directly influence learning. The significant others mentioned here can be counted as the peers, parents, etc., of the individual, while the classroom factor may be considered to be the teacher with whom the individual interacts in the learning environment [17].

Gender difference is a subject considered in many studies into mathematical education. The most often encountered are factors such as mathematical achievement, spatial ability, geometrical achievement, etc., in relation to cognitive levels, and attitude, anxiety, value etc. in the affective field. Studies on the correlation of gender and mathematical achievement, for example, studies among students into gender differences in spatial visualization carried out by [2], have shown that male students have higher skills in spatial visualization. Again, many studies [16, 7, 27] have shown that the gender variable is effective on the mathematical achievement of the students. Many studies [3, 4, 15, 9] conducted on mathematical anxiety, which can be considered an affective factor, also show that, like the cognitive field, the gender variable is effective.

Besides the particulars mentioned above, the gender variable is also considered in studies related to the concept of belief, which may be included in both the cognitive and affective fields. Although belief does not have a universally accepted definition, as stated in [5], mathematical beliefs are considered as personal philosophies or conceptions about the nature of mathematics as well as about teaching and learning mathematics [23]. It can be said that research conducted into mathematical beliefs of teachers and teacher candidates has been generally based on teaching practices. Many studies [22, 6, 26, 5, 21] have shown that mathematical beliefs affect the classroom practices of teachers. There is a common opinion that belief is an important variable in studies concerned with gender as well as classroom practices. Gender is a variable that affects the beliefs and behaviors of the teachers and the beliefs, behaviors and achievements of the students [14]. At this point, the thought comes to mind that, as a determinant of their classroom behavior, the gender variable may naturally be effective in the mathematics teaching anxiety of prospective teachers, as the teachers of the future. However, when the literature is studied, it can be seen that there are not many detailed studies into gender differences in the beliefs of teachers, and the studies that exist show that, although there

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are nuances, there are no differences [14]. As an example, the studies carried out by [8] in our country have not shown any gender differences in the mathematical beliefs of teachers.

When the above mentioned reasons for gender differences are studied, another variable that may arise may be math teaching anxiety. Math teaching anxiety may be defined as “the stress and anxiety teachers experience in teaching mathematical concepts, theorems, formulas or problem solving” [20]. The problem of differential treatment of male and female students by teachers is well documented, and there is no doubt that it strongly influences learning [17]. While this situation brings to mind the possibility that male and female teacher candidates, as the prospective teachers of the future, that come from applications such as these, may have different levels of math teaching anxiety, no research in this field has been encountered. Starting from this point, the present study aims to determine if the gender variable causes differences in either math beliefs or math teaching anxiety, and seeks the answers to the following questions:

1. Do the math beliefs of prospective primary education math teachers differ according to gender?
2. Do the math teaching anxieties of prospective primary education math teachers differ according to gender?

II. METHOD

A. The Model of the Research

Survey models are research methods aiming to describe a past or continuing situation as it is. Here, the event that is the subject of the research is attempted to be defined within its own conditions, and as it exists [11]. As the preferences in math beliefs and math teaching anxieties of the prospective teachers making up the sampling are being investigated from the gender perspective, a general scanning method has been selected as the research model. In a general scanning model, in a universe made up of a large number of elements, scanning is carried out on the entire universe, or on a group taken from the whole, a sample or paradigm. In this research, convenience sampling [19] has been selected as the sampling model.

B. Participants

A total of 290 teacher candidates (207 female and 83 male) from the elementary education mathematics teacher training program of Ahmet Keleşoğlu Education Faculty of Selçuk University participated in the study.

C. Data Collection Tools

The data collecting tools used in this research are the Mathematics Teaching Anxiety Survey (MATAS), developed by [20], and the Beliefs About Mathematics Survey (BAMS), developed by [1].

Mathematics Teaching Anxiety Scale

Math Teaching Anxiety Scale is a likert type scale comprising 23 items. The answers to the items of the scale are, I absolutely agree, I agree, I am undecided, I don't agree and I

absolutely don't agree. Negative responses are valued from 5 to 1, and the positive responses are valued from 1 to 5.

Mathematics Teaching Anxiety Scale, developed by [20], is a four-factor scale. These factors are, anxiety due to subject knowledge (10 items), anxiety due to self-confidence (6 items), anxiety due to the attitude towards teaching mathematics (4 items) and anxiety due to subject teaching knowledge (3 items). The reliability coefficient for the scale as a whole is 0.91, and the reliability factors determined for the sub-factors, respectively, are, 0.90, 0.83, 0.71 and 0.61.

Beliefs About Mathematics Survey

The Beliefs About Mathematics Survey, developed by [1], comprising 20 items, is used to determine the beliefs of prospective teachers about mathematics. The survey is a 4-fold likert-type scale valued from “I agree absolutely” to “I absolutely don't agree”. Responses are valued with points decreasing from 4 for I agree absolutely” to 1 for “I absolutely don't agree”.

The survey has 3 sub-categories, namely, beliefs about the process of learning mathematics (10 items), beliefs about the use of mathematics (7 items) and beliefs about the nature of mathematics (3 items). Reliability coefficients for the scale have been determined as 0.75, 0.71 and 0.66 respectively for the sub-categories, and as 0.75 for the whole of the survey [1].

D. Data Analysis

In determining the preferences of prospective teachers regarding their beliefs about mathematics and math teaching anxieties, descriptive statistics gleaned from the data collecting tools, such as sub-category points and standard deviations were used. Furthermore, an independent sample *t* test was used to determine any differences in the mathematical belief and teaching anxiety variables according to the gender of the candidates.

III. FINDINGS AND IMPLICATIONS

The average points gleaned by the candidates from the surveys regarding their beliefs about mathematics and math teaching anxieties, and the comparison of these points according to the gender of the candidates are given below.

Table 1 shows the results of the survey into the beliefs about mathematics of the prospective teachers making up the sampling, and Table 2 shows the results of the survey into their math teaching anxieties.

TABLE I
COMPARISON OF BELIEF ABOUT MATHEMATICS POINTS ACCORDING TO GENDER

		\bar{X}	<i>Sd</i>	$\bar{X}_{\text{difference}}$	<i>t</i>
Process of Math.	Female	15.14	3.26	- 1.15	- 2.697*
	Male	16.29	3.39		
Use of Math.	Female	23.64	3.16	0.45	1.126
	Male	23.19	2.85		
Nature of Math.	Female	7.04	1.51	0.26	1.319
	Male	6.78	1.55		

Note: * significant at .05; $n_{\text{female}} = 207$, $n_{\text{male}} = 83$

TABLE II
COMPARISON OF MATH TEACHING ANXIETY POINTS ACCORDING TO GENDER

		\bar{X}	Sd	$\bar{X}_{\text{difference}}$	t
Subject Knowledge	Female	20.05	5.08	1.53	2.273*
	Male	18.52	5.42		
Self-confidence	Female	14.38	3.99	1.27	2.565*
	Male	13.11	3.31		
Attitude	Female	7.28	2.59	-0.14	-0.435
	Male	7.42	2.60		
Subject Teaching Knowledge	Female	5.84	1.93	-0.06	-0.248
	Male	5.90	2.04		

Note: * significant at .05; $n_{\text{female}} = 207$, $n_{\text{male}} = 83$

When the statistics relating to the teacher candidates' beliefs about mathematics shown in Table 1, it can be seen that in the sub-category of beliefs about the process of mathematics, an average of 15.14 and a standard deviation of 3.26 for females, and an average of 16.29 with a standard deviation of 3.39 for males have been calculated. The -1.15 point difference between the points for females and males for this sub-category of beliefs about mathematics is significant in favor of the males at a level of $\alpha=0.05$ ($t = -2.697$). That is to say, the beliefs about the process of math learning of the male teacher candidates participating in the study are higher than that of the females. This is an indication that teacher candidates' beliefs about the process of learning mathematics vary according to their gender.

When the values for the other sub-categories of beliefs about mathematics scale, given in Table 1, are studied, it is seen that females generally reach higher points than males. However, it has been determined that neither the 0.45 point difference in the sub-category of belief about the use of math, nor the 0.26 point difference in the sub-category of belief about the nature of math in favor of the females, is significant at the level of $\alpha=0.05$ ($t = 1.126$ and $t = 1.319$). Briefly, it can be said that the beliefs of prospective teachers about the process of learning mathematics are influenced by the gender variable, while the other sub-categories of the scale, the beliefs about the use of math and the nature of math are not influenced by the gender variable.

When the statistics given in Table 2 about the teaching anxiety are studied, it is seen that in the sub-category of anxiety due to subject knowledge, females have an average of 20.05 and 5.08 standard deviation while the males have an average of 18.52 with a standard deviation of 5.42. In the sub-category of self-confidence, these values have been calculated as 14.38 and 3.99 for females and 13.11 and 3.31 for males. When the values are compared, it is seen that females have higher averages in both the subject knowledge and self-confidence sub-categories. Both the 1.53 point difference in the sub-category of subject knowledge and the 1.27 point difference in the self-confidence sub-category have been found significant at the level of $\alpha=0.05$ in favor of the females ($t = 2.273$ and $t = 2.565$). This indicates that females feel more anxiety than males in the sub-categories of both subject

knowledge and self-confidence, or, in other words, the anxiety variable in the mentioned sub-categories differs in relation to the gender variable.

When the values regarding the other sub-categories of math teaching anxiety given in Table 2, even though the both the -0.14 point difference in the attitude sub-category, and the -0.06 point difference in the subject teaching sub-category are in favor of the females, as these differences are not significant from the statistical perspective, it is not possible to say that males feel more anxiety than the females. Briefly, it is possible to say that prospective teachers' math teaching anxieties due to subject knowledge and self-confidence are affected by their gender while their anxieties due to attitude and subject teaching knowledge are not.

IV. DISCUSSION, CONCLUSION AND SUGGESTIONS

In general, it is not possible to say that sufficient studies have been carried out on gender differences of prospective teachers, particularly in regard to beliefs about mathematics and math teaching anxiety variables, discussed in relation with our research.

According to the findings of our study, while there is a significant difference in the sub-category of belief in the process of learning math, one of the sub-categories of beliefs about mathematics, no differences were determined in the sub-categories of the use of math and the nature of math. The significant difference discovered in the sub-category of belief in the process of learning mathematics, when it is considered that females have achieved a lower average than males, indicates that males have a more instrumentalist approach in learning mathematics. Teacher beliefs affect student beliefs, their behaviors and, ultimately, their achievement [14]. Therefore, it is possible that the present outcome has been reached as a result of the traditional teaching model dominantly used in our country, and because the teachers who are the implementers of this model interact more with male students during student-teacher interaction. In fact, as [24] reports two types of sex bias in their studies: boys received more attention from teachers and were given more time to talk in classrooms than girls, and boys received more praise, critical feedback, and remediation than girls. On the other hand, while previous studies [1, 8] show that females and males have similar beliefs about mathematics, the findings of our research differ from these studies, at least in the sub-category of anxiety due to the process of learning mathematics.

Subject knowledge is considered to be one of the reasons for math teaching anxiety by [13]. On the other hand, it is widely believed that by the time learners graduate from high school, boys have learned more mathematics than have girls [17]. According to the results of our research, the fact that females have a higher rate of math teaching anxiety, especially due to subject knowledge can be explained by the fact that males learn more mathematics than females at the university level.

Another sub-category where a difference in math teaching anxiety between females and males is seen is the sub-category of self-confidence. One dimension of the self-sufficiency concept of a prospective math teacher is his/her mastery of the field [25]. With regard to our research, the fact that math teaching anxiety due to self-confidence is higher in females compared to males can also be primarily explained by subject knowledge.

In summary, as a result of our research, while a significant difference according to the gender variable in the sub-category of belief about the process of learning mathematics of the belief about mathematics survey was found, no differences were encountered in the sub-categories of belief in the use and nature of mathematics. While differences were encountered in the sub-categories of subject knowledge and self-confidence of the math teaching anxiety, differences were not recorded in the sub-categories of anxiety due to attitude and to subject teaching knowledge.

Our research has a quantitative paradigm. In-depth investigations into the reasons of gender differences encountered in the variables of both mathematical beliefs and mathematic teaching anxiety in future qualitative research will play a significant role in the training of prospective teachers who will have the most important mission in the classrooms of the future, and will guide us, the teacher educators.

REFERENCES

- [1] Aksu, M., Demir, C. ve Sümer, Z. (2002). Students' Beliefs about Mathematics: A Descriptive Study, *Eğitim ve Bilim*, 27(123), 72-77.
- [2] Alansari, B. M., Deregowski, J.B. & McGeorge, P. (2008). Sex differences in spatial visualization of Kuwaiti school children. *Social Behaviour and Personality*, 36 (6), 811-824.
- [3] Aydın, E., Delice, A., Dilmaç, B. & Ertekin, E. (2009). The Influence of Gender, Grade and Institution on Primary School Mathematics Student Teachers' Anxiety Levels. *Elementary Education Online*, 8(1), 231-242. [Online]: <http://ilkogretimonline.org.tr>
- [4] Baloglu, M. (2004). Statistics Anxiety and Mathematics Anxiety: Some Interesting Differences. *Education Research Quarterly*, 27(3):38-49.
- [5] Beswick, K. (2007). Teachers' beliefs that matter in secondary mathematics classrooms. *Educational Studies in Mathematics*, 65, pp. 95-120.
- [6] Cross, D.I., (2009). Alignment, cohesion, and change: examining mathematics teachers' beliefs structures and their influence on instructional practices. *J. Math. Teacher Educ.*, 12, pp.325-346.
- [7] Dayoğlu, M. & Türüt-Aşık, S. (2007). Gender differences in academic performance in a large public university in Turkey. *Higher Education*, 53: 255-277.
- [8] Duatpe-Paksu, A. (2008). Comparing Teachers' beliefs about mathematics in terms of their branches and gender. *H.U. Journal of Education*, 35: 87-97.
- [9] Erkin, E. (1993). The Relationship between Math Anxiety, Attitude toward Mathematics and Classroom Environment. 14. International Conference of Stress and Anxiety Research Society (STAR), Cairo, Egypt, April 5-7 1993.
- [10] Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest*, 8(1), 1-51.
- [11] Karasar, N. (2000). *Bilimsel Araştırma Yöntemleri*. Ankara: Nobel Yayınevi.
- [12] Leder, G. C. (1992). Mathematics and gender: changing perspectives. In Douglas A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning*. New York, Macmillan.
- [13] Levine, G. (1993). Prior mathematics history, anticipated mathematics teaching style and anxiety for teaching mathematics among pre-service elementary school teachers. Paper Presented at the Annual Meeting of the International Group for Psychology of Mathematics Education, North American Chapter.
- [14] Li, Q. (1999). Teachers' beliefs and gender differences in mathematics: a review. *Educational Research*, 41: 1, 63-76.
- [15] Marsh, G.E. ve Tapai, M. (2002). Feeling Good about Mathematics: Are There Sex Differences? ERIC No: ED 474446.
- [16] Melkonian, M. & Ierokipiotis, E. (1997). The effect of age-position and sex on academic performance: a study of secondary schools in Cyprus. *Educational Research*, 39 (3), 355-363.
- [17] Meyer, M. R. & Fennema, E. (1992). Girls, boys and mathematics. In Thomas R. Post (Ed), *Teaching Mathematics in Grades K-8: Research Based Methods*. Massachusetts, Allyn and Bacon.
- [18] Opyene-Eluk, P. & Opolot-Okurut, C. (1995). Gender and school-type differences in mathematics achievement of senior three pupils in central Uganda: an exploratory study. *International Journal of Mathematical Education in Science and Technology*, 26: 6, 871-886.
- [19] Patton, M.Q. (1990). *Qualitative Evaluation and Research Methods*. SAGE Publications. Newbury Park London New Delhi.
- [20] Peker, M. (2006). Matematik öğretmeye yönelik kaygı ölçeğinin geliştirilmesi. *Eğitim Bilimleri ve Uygulama*, 9, 73-92.
- [21] Son, J-W. & Crespo, S. (2009). Prospective teachers' reasoning and response to a student's non-traditional strategy when dividing fractions. *J. Math. Teacher Educ.*, 12, pp. 235-261.
- [22] Stipek, D. J., Givvin, K. B., Salmon, J. M. & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education*, 17, pp. 213-226.
- [23] 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* (pp. 127-146). New York: Macmillan.
- [24] Tiedemann, J. (2002). Teachers' gender stereotypes as determinants of teacher perceptions in elementary school mathematics. *Educational Studies in Mathematics*, 50: 49-62.
- [25] Umay, A. (2002). "İlköğretim Matematik Öğretmenliği Programının Öğrencilerin Matematiğe Karşı Özyeterlik Algısına Etkisi" V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi. (16-18 Eylül 2002). Ankara: ODTÜ Kültür ve Kongre Merkezi.
- [26] Wilkins, J.L.M. (2008). The relationship among elementary teachers' content knowledge, attitudes, beliefs, and practices. *J. Math Teacher Educ.*, 11, pp. 139-164.
- [27] Winkelmann, H., Heuvel-Panhuizen, M. & Robitzsch, A. (2008). Gender differences in the mathematics achievements of German primary school students: results from a German large-scale study. *ZDM Mathematics Education*, 40: 601-616.