

Full Length Research Paper

The relationship between epistemological beliefs and teaching anxiety in mathematics

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The purpose of this study is to investigate the relationship between the anxiety of teaching mathematics and epistemological beliefs of prospective teachers. Research was carried out on 279 teacher candidates studying in the primary education mathematics teaching, secondary education mathematics teaching and class teaching programs. A 23-item Mathematics Teaching Anxiety Scale and a 35-item Epistemological Belief Scale were applied to the teacher candidates included in the sampling. In the analysis of the data, the Pearson Product-Moment Correlation Coefficient analysis was applied to determine the relationship between the anxiety of teaching mathematics and epistemological beliefs. As a result of the analysis, it has been determined that a weak, negative correlation exists between the anxiety of teaching mathematics and epistemological beliefs in the teacher candidates.

Key words: Mathematics, teaching anxiety, epistemological beliefs, prospective teacher.

INTRODUCTION

Although belief does not have a definition on which there is a general consensus, according to Beswick (2007) Ajzen and Fischbein (1980) defined belief as anything that an individual regards as true. Beliefs, whatever their source, are related to one another, forming systems in which related beliefs are connected (Rokeach, 1968: Cited in Ambrose, 2004). Within the belief systems of individuals, epistemological beliefs are considered to be core beliefs (Brownlee et al., 2002).

Epistemological beliefs, as they are conceived of by educational psychologists, are beliefs about the nature of knowledge. Depending upon the theory, these may include beliefs about the certainty, source, justification, acquisition and structure of knowledge (Duell and Schommer-Aikins, 2001). On the other hand, Deryakulu

(2004) defines epistemological beliefs in the widest sense as the subjective beliefs of individuals on what knowledge is, and how, knowing and learning are realized. Most research regards epistemological beliefs as valid for all domains, however, Hofer (2000) has suggested that epistemological beliefs are domain-specific (cited in: Banks, 2005). Studies in different disciplines, especially those in the domains of mathematics and science, show that epistemological beliefs can change from one domain to the other (Banks, 2005). As example, in the study carried out by Ertekin et al. (2009) on teacher candidates in the domains of mathematics and social sciences, it was determined that the beliefs of the candidates in the subscale of "belief that learning requires talent" in the epistemological belief scale were quite different. In a similar study, Paulsen and Wells (1998) determined that the epistemological beliefs of college students differed in conjunction with their field of study.

One of the domains where the effects of epistemological beliefs on the behavior of individuals can clearly be observed is mathematics. Mathematical beliefs are considered as personal philosophies or conceptions about the nature of mathematics as well as about teaching and learning mathematics (Thompson, 1992).

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Abbreviations: **MATAS**, Mathematics teaching anxiety scale; **EBS**, epistemological belief scale; **BLRE**, belief that learning requires effort; **BLRT**, belief that learning requires talent; **BS**, belief in a single truth.

The beliefs of the prospective teachers and teachers on the nature of mathematics as a part of the belief system are a part of the domain-specific beliefs, and may be considered the epistemological side of belief. When the beliefs of teacher candidates in teaching mathematics are studied, literature suggests that they see mathematics as an authoritarian discipline, and that they believe that doing mathematics means applying memorized formulas and procedures (Szydlik et al., 2003). The selection of the activities to be carried out in class is largely dependent, not only on the knowledge of the teacher, but also on his/her epistemological conceptions of mathematics and mathematics education (Steinberg, 1998). The fact that studies on beliefs and the practice of teaching (e.g. Stipek et al., 2001; Cross, 2009; Wilkins, 2008; Son and Crespo, 2009) show that there is a correlation between teachers' beliefs and teaching practices clearly exhibits the necessity of not leaving the teaching of mathematics in the hands of teachers who nurture the belief that mathematics is a bunch of meaningless rules, and the need to develop the beliefs, especially of the teachers of the future (teacher candidates). However, universities often require courses designed to enhance prospective teachers' mathematical knowledge by having them make sense of mathematics and understand the principles that underlie the arithmetic they memorized as children. Often, efforts to change prospective teachers' beliefs are initiated in methods courses after subject matter courses have been completed and when they are applied too late to develop beliefs that will help the teachers in developing a deep understanding of fundamental mathematics (Ambrose, 2004). Comprehensive reviews of studies illustrated the relevance of epistemological beliefs for learning and problem solving (Op't Eynde et al., 2006).

In our opinion, when the level of epistemological beliefs about the nature of knowledge is considered, it is clear to what extent a prospective teacher who, as mentioned before, sees mathematics as a total of rules to be memorized, will endeavor to learn mathematical subjects in university education, together with preliminary learning. Furthermore, due to a lack of meaningful effort, their learning of mathematics will also be insufficient.

The incomplete cognitive level of a prospective teacher with insufficient content knowledge will also cause the development of various negative effective characteristics. One of those characteristics is the mathematics teaching anxiety. Levine (1996) has stated that the anxiety of prospective teachers with high levels of mathematics teaching anxiety is related to their previous, insufficient knowledge of mathematics and unpleasant experiences to do with learning mathematics. Mathematics teaching anxiety may be defined as "the stress and anxiety experienced by teachers in teaching mathematical concepts, theorems, formula or problem solving" (Peker, 2006). In his study, Levine (1996) has observed that the anxiety levels of some of the prospective teachers with high

levels of mathematics teaching anxiety increased during abstract discussions, and found, as a result of research, that prospective teachers with mathematics teaching anxiety were also inadequate in learning how to teach mathematics and in producing material. On the other hand, Peker (2008) has stated that as the need for concretization of the subject to be taught increased, so did the mathematics teaching anxiety of the prospective teachers. However, literature cites some factors that affect the mathematics teaching anxiety. For example, Peker, (2009a/2009b) and Peker and Halat (2009) have observed that the teaching methods used in teacher training programs affect the mathematics teaching anxiety of prospective teachers. Peker (2009c) has stated that the mathematics teaching anxiety of prospective teachers differed according to their learning styles. However, it has also been pointed out that other factors that might be correlated with mathematics teaching anxiety must also be investigated.

The points touched on above indicate that there might be a correlation between epistemological beliefs and mathematics teaching anxiety. Therefore, the lack of similar studies in literature makes it necessary to determine the existence and degree of correlation between two variables. For this reason, the present study aims to investigate whether there is a correlation between the epistemological beliefs and the mathematics teaching anxiety of prospective teachers, and to contribute to mathematics teaching and literature.

METHODS

The research has a quantitative paradigm in relation to data. A general screening method has been used for the study. According to Karasar (2000), screening models are research models aiming to depict a past or continuing situation as it is. Here, the attempt is made to define the event that is subject to research under its own conditions, and as it is. In the general screening model, in a universe that is made up of a large number of elements, screening is carried out on the entire universe, or a group, sample or sampling taken from it. In this study, convenience sampling (Patton, 1990) has been chosen as the sampling method.

Participants

143 prospective teachers from the primary education mathematics teacher training program, 25 teacher candidates from the secondary education mathematics teacher training program, and 111 from the class teacher training program of Ahmet Keleşoğlu Educational Department of the Selçuk University participated in the study. The fact that prospective teachers from the mentioned programs will be teaching mathematics in their professional lives may be shown as the reason they were included in the sampling for the research.

Data collecting tools

In this study, the Mathematics Teaching Anxiety Scale developed by Peker (2006) and the Epistemological Beliefs Scale developed by Schommer (1990) were used.

Mathematics teaching anxiety scale

Mathematics Teaching Anxiety Scale (MATAS) is a Likert type scale made up of 23 items. The answers that can be given to the items in the scale are: 'I agree absolutely', 'I agree', 'I am undecided', 'I disagree', and 'I disagree absolutely'. Negative statements have been given points from 5 to 1, and positive responses from 1 to 5. Total points have been calculated as the mathematics teaching anxiety points of the prospective teacher.

MATAS, developed by Peker (2006), is a 4-factor scale. These factors are: Anxiety arising from content knowledge, made up of 10 items, and with factor weights between 0.53 and 0.86; anxiety arising from self-confidence, made up of 6 items and with factor weights between 0.57 and 0.76; anxiety arising from the attitude towards teaching mathematics, comprising 4 items with factor weights between 0.61 and 0.70; and anxiety arising from teaching knowledge, made up of 3 items with factor weights between 0.68 and 0.78. The reliability coefficient of the scale is 0.91, and the calculated reliability coefficients for each of the sub-factors are: 0.90 for the sub-factor of anxiety arising from content knowledge, 0.83 for the sub-factor of self-confidence, 0.71 for the sub-factor of anxiety arising from the attitude towards teaching mathematics, and 0.61 for the sub-factor of anxiety arising from teaching knowledge.

Epistemological belief scale

The Epistemological Belief Scale (EBS), developed by Schommer (1990) for the purpose of determining the epistemological beliefs of students, and the validity and reliability on Turkish university students determined by Deryakulu and Büyüköztürk (2002), has been used. The original scale comprises four sub-levels, namely, "Fixed Talent", "Learning is Spontaneous", "Knowledge is Simple" and "Knowledge is Absolute". When the scale is adapted to Turkey, due to cultural differences, there are three sub-levels, namely "belief that learning requires effort" (BLRE), "belief that learning requires talent" (BLRT) and "belief in a single truth" (BST). The scale is a Likert type scale with 5 stages between (1) *I disagree absolutely* and (5) *I agree absolutely*. The evaluation of the points from the scale is carried out on a level basis, and the points for the entire scale are not evaluated. The BLRE sub-level of the scale has a total of 18 items, 17 negative and 1 positive. A sample item in this subscale is as follows: "If somebody does not understand something in a short period of time, he/she should continue to spend effort to understand it." In the BLRT subscale of the scale, there are 9 items, all positive. An example item is, "The truly intelligent students do not need to study hard at school." There are 8 items in the BST subscale of the scale, all of them positive. One sample item is, "The best part of science is that most problems have only one correct answer." High points received in each subscale show that the individual has matured/developed beliefs in that level. The test, re-test reliability coefficient of the original scale is 0.74, and the reliability coefficients of the subscales are between 0.63 and 0.85 (Schommer, 1993). The Cronbach Alpha internal coherence coefficients of the adapted 35-item scale have been calculated as 0.83 for the first level, 0.62 for the second level, 0.59 for the third level and 0.71 for the entire scale (Deryakulu and Büyüköztürk, 2002).

Data analysis

Pearson Product-Moment Correlation Coefficient analysis was used in the calculation of the correlation coefficients between the variables, and regression analysis was utilized in testing the regressive power of epistemological beliefs on the mathematics teaching anxiety level.

FINDINGS

In determining the relationships between the epistemological beliefs of the prospective teachers participating in the study and their mathematics teaching anxieties, the correlations between the total subscale points were calculated, and the values shown in Table 1 were obtained.

When the correlations between the points from the three subscales of epistemological beliefs of prospective teachers and the four subscales of their teaching anxieties, shown in Table 1, are studied, it is seen that the values change between -0.190 and -0.075. The negative sign of all correlations indicate an inverse relationship between the epistemological beliefs and teaching anxieties of prospective teachers. Besides being negative, correlation coefficients are at a very low level. However, except for the belief subscale of "belief in a single truth", the correlations between the other two belief subscale and all four subscales of teaching anxiety have been found significant (the correlations between anxiety subscale 3 and belief subscales 1 and 2, and between anxiety subscale 2 and belief subscale 2 are at the 0.01 level). The correlations between anxiety subscale 4 and belief subscale 2, and belief subscale 3 and all subscales of anxiety, at the 0.05 level, were not found significant. For a better determination of the correlation between the epistemological beliefs and teaching anxieties of prospective teachers, following the correlation study, a regression study was carried out. In the regression study, while the epistemological belief subscale points of the teacher candidates were taken as independent variables, the teaching anxiety subscale points were treated separately as dependent variables and regression tables were formed. The obtained results of the regression analyses are shown in Table 2 and the following tables.

As can be seen from Table 2, according to the results of the regression analysis, the subscales of the epistemological scale explain the first subscale of teaching anxiety at a level of 0.05. That is, the power of the subscales of the epistemological belief scale to explain the first subscale of the teaching anxiety scale, which is the prospective teachers' content knowledge, is only 0.05. While this value is at a level which cannot be considered high, it is meaningful at the level of $\alpha=0.01$ ($F=4.815$). This can be interpreted as meaning that 0.05 of the variable belonging to the first subscale of the teaching anxiety arises from the subscales of the epistemological belief scale, and the rest arises from other variables not included in the research. Furthermore, when the t values for the subscales of the belief scale are studied, the subscales (belief that learning requires talent and belief in a single truth) other than that of belief that learning requires effort significantly explain the first subscale of the teaching anxiety ($t = -2.458$ and $t = 2.294$).

As can be seen from Table 3, according to the results

Table 1. Correlations between the epistemological belief points and mathematics teaching anxiety points of prospective teachers.

Belief Anxiety (n=279)	Belief that learning requires effort subscale	Belief that learning requires talent subscale	Belief in a single truth subscale
Teacher candidates' content knowledge subscale in mathematics teaching anxiety	-0.148*	-0.146*	-0.097
Teacher candidates' self-confidence subscale in mathematics teaching anxiety	-0.119*	-0.156**	-0.076
Teacher candidates' attitude towards teaching mathematics in mathematics teaching anxiety	-0.189**	-0.190**	-0.108
Teacher candidates' teaching knowledge subscale in mathematics teaching anxiety	- 0.119*	-0.112	-0.075

Table 2. Teaching anxiety – content knowledge of prospective teachers subscale.

Model	R	R²	F
Belief	0.223	0.05	4.815**

Variable	Unstandardized Beta	Std. error	Std. beta	t
Belief that learning requires effort	-0.04	0.04	-0.07	-1.111
Belief that learning requires talent	-0.22	0.09	-0.17	-2.458*
Belief in a single truth	0.22	0.10	0.15	2.294*

Table 3. Teaching anxiety – self-confidence of prospective teachers subscale.

Model	R	R²	F
Belief	0.175	0.03	2.883*

Variable	Unstandardized beta	Std. error	Std. beta	t
Belief that learning requires effort	-0.03	0.03	-0.08	-1.240
Belief that learning requires talent	-0.10	0.06	-0.11	-1.588
Belief in a single truth	0.05	0.07	0.05	0.699

of the regression analysis, the power of the subscales of the epistemological belief scale to explain the second subscale of the teaching anxiety scale, which is the self-confidence of prospective teachers, is only 0.03. This value has been found significant at a level of $\alpha=0.05$ ($F=2.883$). Furthermore, when the t values for the subscales of the belief scale are studied, it has been observed that, of the t values belonging to the belief scale subscales, none is significant at $\alpha=0.05$ level.

As can be seen from Table 4, the power of the subscales of the epistemological belief scale to explain the third subscale of the teaching anxiety scale, which is the attitude of prospective teachers, is 0.06. This value has been found significant at a level of $\alpha=0.01$ ($F = 5.736$). Furthermore, when the t values for the subscales of the belief scale are studied, it can be seen that the t value for the belief that learning requires effort subscale

is significant at $\alpha=0.05$ level ($t = - 2.456$) while the values for the other subscales are not significant.

According to the results of the regression analysis in Table 5, the power of the subscales of the epistemological belief scale to explain the fourth subscale of the teaching anxiety scale, which is the teaching knowledge of prospective teachers, is only 0.02. This value has not been found significant at a level of $\alpha=0.05$ ($F=2.189$). That is, there is no definite proof that the sub-factors of the belief scale significantly explain the teaching knowledge sub-factor of prospective teachers. Furthermore, when the t values for the belief sub-factors are studied, it can be seen that none of the t values for any of the sub-factors of the belief scale is significant at the level of $\alpha=0.05$. This can be interpreted as meaning that, using the results of this study; no presumptions can be made about the teaching knowledge of the

Table 4. Teaching anxiety – attitude of prospective teachers subscale.

Model	R		R ²	F
Belief	0.243		0.06	5.736**
Variable	Unstandardized beta	Std. error	Std. beta	t
Belief that learning requires effort	-0.05	0.02	-0.16	-2.456*
Belief that learning requires talent	-0.07	0.05	-0.10	-1.478
Belief in a single truth	0.07	0.05	-0.09	-1.359

Table 5. Teaching anxiety – teaching knowledge of prospective teachers subscale.

Model	R		R ²	F
Belief	0.153		0.02	2.189
Variable	Unstandardized beta	Std. error	Std. beta	t
Belief that learning requires effort	-0.02	0.02	-0.11	-1.619
Belief that learning requires talent	-0.03	0.04	-0.49	-0.698
Belief in a single truth	-0.04	0.04	-0.07	-1.041

prospective teachers by using data related to their epistemological beliefs.

DISCUSSION AND CONCLUSION

A discussion process was carried out in the light of the findings obtained from our study of the relationship between the mathematics teaching anxiety of prospective teachers and their epistemological beliefs. However, when both domestic and international studies in this field are scrutinized, none have been found that take in hand the correlation between mathematics teaching anxiety and epistemological beliefs in prospective teachers.

Literature shows that there is a relationship between beliefs and in-class applications of teachers (Stipek et al., 2001; Cross, 2009; Wilkins, 2008; Beswick, 2007; Son and Crespo, 2009). Regarding our study, when the fact that anxiety is a state of dread in the face of an expected danger is taken into consideration, the correlation between the beliefs of prospective teachers and their mathematics teaching anxiety supports the effectiveness of beliefs, albeit in a roundabout way, and shows parallelism with research results in this respect.

The correlations between the points of the epistemological beliefs of prospective teachers and their teaching anxiety show that there is an inverse relationship between the epistemological beliefs and teaching anxiety of prospective teachers. The fact that the sub-factors of “belief that learning requires effort” and “belief that learning requires talent” of the epistemological belief scale has significant correlations with almost all sub-factors of the mathematics teaching anxiety scale can be

interpreted as meaning that epistemological beliefs about the way knowledge is obtained are more in the forefront in explaining mathematics teaching anxiety than epistemological beliefs about the nature of knowledge. The negative correlation between the sub-factors of belief that learning requires talent or effort and mathematics teaching anxiety shows that as belief in these increases, mathematics teaching anxiety decreases.

According to the findings of our study, the sub-factors of the epistemological belief scale significantly explain the sub-factors of “prospective teachers’ attitude in mathematics teaching anxiety,” “prospective teachers’ content knowledge in mathematics teaching anxiety” and “prospective teachers’ self-confidence in mathematics teaching anxiety.” However, they do not explain the fourth sub-factor of “prospective teachers’ teaching knowledge in mathematics teaching anxiety,” with any significance. This shows us that while epistemological beliefs are a determinant of the components of attitude, content knowledge and self-confidence, but not a determinant of the teaching knowledge factor. This fact can be explained by prospective teachers seeing the institutions where they have been trained as authorities in these domains, and by their loyalty to these institutions.

When the inverse correlation between the epistemological beliefs and mathematics teaching anxieties of prospective teachers, determined through this study, is considered together with the findings of the regression of the epistemological belief sub-factors on the mathematics teaching anxiety, it can be said that by using the epistemological beliefs of prospective teachers, it is possible to predict their mathematical teaching anxieties, and these anxieties can be alleviated by developing

these beliefs. The significant negative correlation coefficients between epistemological beliefs and mathematics teaching anxiety is an indication that mathematics teaching anxiety can be reduced by developing the epistemological beliefs (especially those regarding learning being dependent on talent or effort) of individuals. Furthermore, while their explanatory strengths are low, the fact that the components of epistemological beliefs can be used in regressing the different sub-factors of the mathematics teaching anxiety enables the relative control of the mathematical teaching anxiety of teachers, the most important components of mathematics education, which directly impacts their mathematics teaching performance (Levine, 1996). This fact, as it will increase the mathematics teaching performance of teachers, is considered to be important, and necessitates the adaptation of similar studies to include more detail. The results of the study on epistemological beliefs point to the highly domain-specific nature of students' beliefs about knowledge and knowing (Op't Eynde et al., 2006). Therefore, more detailed findings may be reached by considering the domain-specific beliefs of prospective teachers in a similar study.

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