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THE MEDIATING ROLE OF PROSPECTIVE MATHEMATICS TEACHERS' BELIEFS ON THE RELATIONSHIP BETWEEN PERCEPTIONS AND ATTITUDES

Berna CANTÜRK GÜNHAN

Abstract: The aim of this study is to investigate the mediation effects of prospective mathematics teachers' beliefs about mathematics on the relationship between perception of pedagogical content knowledge and attitude towards mathematics teaching. Data of the study was collected from 295 prospective mathematics teachers who study at elementary mathematics teaching in education faculty of a state university. Three scales were used for the variables mentioned in this subject. The relation between these variables was analyzed through statistical methods such as regression analysis and sobel tests. As a result of the study, it was determined that the prospective mathematics teachers' perceptions of pedagogical content knowledge affect their attitudes toward mathematics teaching positively. It was also found that the relationship between perception of pedagogical content knowledge and attitude toward mathematics teaching was fully mediated by their beliefs about mathematics.

Key words: perception of pedagogical content knowledge; attitude toward mathematics teaching; belief about mathematics; mediating role.

1. Introduction

It cannot be denied that in mathematic teaching; teacher perceptions, beliefs, attitudes and behaviours have an important role in learning environment. Teachers' behaviours influence in class practices (Richardson 1996; Pajares 1992; Thompson 1992, 1984) and learning of students (Enochs, Smith & Huinker, 2000; Frykholm, 2003; Kayan & Çakıroğlu, 2008; Lloyd & Wilson, 1998). In addition to this, teacher attitudes are important determinant of student attitudes (Aiken, 1970, p572). Fennema, Carpenter and Peterson (1989) have developed a model that teachers' beliefs affect teachers' decisions about how to implement classroom instruction. Also, it is stated in studies that teacher beliefs play important role on behaviours and attitudes in teaching process (Incikabi, 2013; Kayan & Çakıroğlu, 2008; Toluk Uçar & Demirsoy, 2010). Moreover, Hannula, Maijala and Pehkonen (2004) found that the learning of mathematics was influenced by a student's beliefs about mathematics. Koballa and Crawley (1985) stated, there is an important interaction between belief, attitude and behaviour. Bandura (1986) stated that what people believe and how they feel effect how they behave. In this sense, institution which train teachers should overemphasize perceptions, beliefs and attitudes of prospective mathematics teachers towards mathematic teaching.

Beliefs in themselves are the basis for the development of positive attitudes towards a situation and the emergence of positive behaviors (Koballa & Crawley, 1985). Stating that beliefs consist of personal experiences, Nespor (1987) states that teachers' beliefs can develop as a result of their experiences both inside and outside the school. For this reason, it is very important for the prospective teachers to understand their belief structures and to develop their professional development and teaching practices (Pajares, 1992). Researchers emphasize that an individual's beliefs have a significant impact on decisions, choices, and behaviors throughout his life (Stipek, Givvin, Salmon & MacGyvers, 2001; Thompson, 1992; Deryakulu, 2004; Hofer & Pintrich, 1997; Pajares, 1992). Schoenfeld (1985) states

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that belief shows people's experiences and mental structures in understanding, perceptions and cognitions in any situation. Ernest (1989, page 20) defines belief towards mathematics as "comprehension, values, ideology and tendency of individuals towards mathematics". Raymond (1997) defines beliefs about mathematics as decisions of people about nature, learning and teaching of mathematics which are shaped with their experiences. One of the most important goals of teacher training is to enable prospective teachers to develop beliefs that will help them become competent teachers (Green, 1971). Since the beliefs of prospective teachers will affect their teaching in their professional lives (Lester & Garofalo, 1987), knowing these beliefs is important in terms of revealing the effectiveness of teacher training programs (Kagan, 1992). It is also important to know what prospective teachers' beliefs affect. Because teachers' beliefs affect their course planning, decisions, attitudes and behaviors in the classroom (Irez, 2007; Bandura, 1986). Attitude is a phenomenon which is adopted through learning, directs behaviours of individual, and cause bias in the process of decision taking (Ülgen, 1997). According to Freedman, Sears and Carlsmith (2003), attitude is a highly permanent system with cognitive, emotional elements and behavioral tendency. Depending on the definition, we can say that attitude is a tendency which prepares the behaviour. Alcı and Erden (2006) determined in their study that students of teachers with positive attitude were more successful than students of teachers with negative attitude in mathematics courses. In the studies, it is found that there is a positive and significant relation between attitude towards teaching and beliefs towards teaching of courses of elementary mathematics prospective teachers (Göloğlu Demir; 2011), biology prospective teachers (Gülev, 2008), chemistry prospective teachers (Morgil, Seçken & Yücel; 2004), science prospective teachers (Özkan, Tekkaya & Çakıroğlu; 2002). At this point, it is important to know beliefs and attitudes of prospective teachers. Moreover, it is necessary to give importance to development of perception in order to free belief formation. Because perception turns into opinion when it is related with personal accumulations, opinions turn into value and then belief (Bülbül, 2013). What does perception mean? Perception is the process of making sense and interpreting sensory information (Senemoğlu, 2011). Perception is effected from previous experiences and environment (Öztürk & Kışaç, 2006). In addition, when it is considered that individuals learn through perceiving (Gökdağ, 2010); it is required to examine prospective teachers' perception, beliefs and attitudes towards mathematics teaching in order to predict their behaviours of towards mathematics teaching.

This study focuses on direct and indirect (mediate) role of variables which effect prospective teachers' attitude towards mathematics education. When the role of teacher is considered in low mathematic success of our country in international examinations, behaviours of teachers should be analyzed. When studies on perceptions, beliefs and attitudes of teachers and prospective teachers towards mathematics in our country are examined, while there are a few studies analyzing their self-efficacy beliefs (Dede, 2008; Doruk & Kaplan, 2012), beliefs about the nature of, teaching, and learning mathematics (Kayan, Haser & Bostan Işıksal, 2013) and attitude towards mathematics education (Göloğlu Demir, 2011), it is seen that variables in these studies are directly related with each other but mediating variables are not considered. In this study, it is aimed to analyze whether there is a direct or indirect (mediate) effect of prospective mathematics teachers' beliefs about mathematics on the relationship between perceptions of pedagogical content knowledge and attitudes toward mathematics teaching. It is thought that the results obtained in this study will guide the institutions that train mathematics teachers.

2. Methods

2. 1. Research Design

This study is a quantitative study aimed at determining the effect of prospective teachers' perceptions of pedagogical content knowledge on the attitudes towards mathematics teaching and whether the prospective mathematics teachers' beliefs about mathematics have a mediating role in this effect.

2. 2. Participants

The participants of this study were 295 prospective mathematics teachers who study at elementary mathematics teaching program. It is known that content teaching courses such as special teaching methods affect teachers' beliefs in mathematics (Haser & Doğan, 2012). Most of the pedagogical content knowledge courses in mathematics teacher education programme in Turkey is located in the 3rd and 4th grade (Yükseköğretim Kurulu-YÖK, 2007). For this reason, the 3rd and 4th grade prospective mathematics teachers were taken. Distributions of research participants according to gender and classes are given in Table 1.

Table 1. *Distributions of Participants' Gender and Classes*

		Class		Total
		3. Class	4. Class	
Gender	Female	116	90	206
	Male	36	53	89
Total		152	143	295

2. 3. Data Collection Tools

Three scales were used to collect data.

2.3.1. Mathematics Education Attitudes (MEA) Scale. It is aimed to put forward attitudes of elementary mathematic prospective teachers towards mathematic teaching with the MEA-Scale. The 25-item scale in a 5-point Likert-type response format was developed by Göloğlu Demir (2011). She called the scale the MAE. According to the exploratory factor analysis conducted to determine the construct validity of the scale, it was found that the items were gathered in three factors. These factors are: liking mathematic teaching (10 items), giving value to mathematic teaching (11 items) and giving importance to mathematic teaching (4 items). The factors of the scale were found to be reliable with Cronbach's alpha coefficient value of .91, .86, and .70 respectively. The reliability of the whole scale was found to be 0.92. Receiving high score from this scale points out that pre-service teachers reflect positive attitude towards mathematic teaching (Göloğlu Demir, 2011). The Cronbach's alpha coefficient calculated for this study was found to be very high with .90.

2.3.2. Perception of Pedagogical Content Knowledge (PPCK) Scale. The PPCK-Scale (Bukova Güzel, Cantürk Günhan, Kula, Özgür & Elçi, 2013) was used to assess prospective teachers' perceptions of pedagogical content knowledge (PPCK) and to define level of the prospective teachers' perceptions regarding their PCK as they begin to their coursework in the teacher education program. Researchers by the result of the exploratory and confirmatory factor analysis, the PPCK-Scale has a five-factor scale composed of 17 items: knowledge of teaching strategies (3 items), knowledge of mathematical language and symbols (2 items), knowledge of misconceptions (3 items), knowledge of learners (2 items), and knowledge of curriculum (7 items). The factors of the scale were found to be reliable with Cronbach's coefficient alpha value of .78, .60, .73, .64, and .83, respectively. The reliability of the whole scale was found to be .87. High score obtained from the scale is evaluated as that perception of PCK is high level (Bukova Güzel et al., 2013). The Cronbach's alpha coefficient calculated for this study was found to be very high with .88.

2.3.3. Mathematics Related Beliefs (MRB) Scale. The MRB-Scale aims to display beliefs of prospective mathematics teachers' beliefs about the nature of, teaching, and learning mathematics. The scale which is composed of 26 items is developed by Kayan, Haser and Bostan Işıksal (2013). They shortened the name of scale to MRB. According to exploratory factor analysis which was carried out in order to determine construct validity of the scale, it was seen that items of scale was grouped in two factors. These factors: traditional beliefs (6 items) and constructivist beliefs (20 items). The factors of the scale were found to be reliable with Cronbach's alpha coefficient value of .737 and .835 respectively. The reliability of the whole scale was found to be .824. Receiving high score from this scale points out that prospective teachers' beliefs have high level (Kayan et al., 2013). The Cronbach's alpha coefficient calculated for this study was found to be very high with .84.

2. 4. Process

Participants of the research were informed before the practice that "this practice has the aim of scientific research and filling the scales requires volunteering". Then volunteer students were briefly informed by the researcher about the study and how to fill in scales, research scale set was handed out. It lasted about 30 minutes to fill in scale questions.

2. 5. Data Analysis

For the analyses of research, SPSS 20.0 package program, confirmatory factor analyses (CFA) and Lisrel program was used. Criteria determined for evaluation of CFA analysis results were given in Table 2.

Table 2. *CFA model fit indexes* (Çokluk et al., 2010, p. 271).

Fit Index	Excellent Fit	Good Fit
X^2/df	$0 \leq X^2/df \leq 2$	$2 \leq X^2/df \leq 3$
CFI	$0.95 \leq CFI \leq 1.00$	$0.90 \leq CFI \leq 0.95$
GFI	$0.95 \leq GFI \leq 1.00$	$0.90 \leq GFI \leq 0.95$
RMR	$0 \leq RMR \leq 0.05$	$0.05 \leq RMR \leq 0.08$
SRMR	$0 \leq SRMR \leq 0.05$	$0.05 \leq SRMR \leq 0.08$
RMSEA	$0 \leq RMSEA \leq 0.05$	$0.05 \leq RMSEA \leq 0.08$

For the purpose of the study, correlation analysis was performed to determine the relationship between PPCK, MRB and MEA scales. In addition, hierarchical regression analysis was used for the mediation effects of mathematics related beliefs (MRB) on the relationship between perception of pedagogical content knowledge (PPCK) and mathematics education attitude (MAE), and sobel test was used for mediation effect calculation. Research model which is formed in the study in this sense is presented in Figure 1.

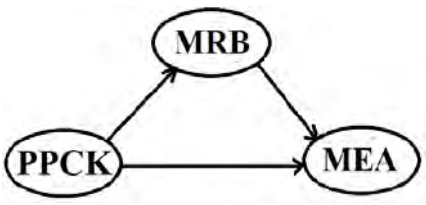


Figure1. *Research Model for Mediating Effect*

3. Results

3. 1. Preliminary analyses

In the preliminary analysis, the factor structure of the three scales was examined through confirmatory factor analysis (CFA). Both the second-order factor model and the first-order factor model of the three scales were tested. Findings related to these scales are presented in Table 3.

Table 3. *CFA model fit indexes for the Scales' Second-Order and First-Order Factor model*

Scales	Cronbach's Alpha coefficient	χ^2	df	X^2/df	CFI	GFI	RMR	SRMR	RMSEA
MEA Scale		815.45	272	2.99	.83	.82	.036	.083	.08

(first-order factor)	.90								
MEA Scale (second-order factor)		656.97	270	2.43	.87	.85	.035	.082	.07
PPCK Scale (first-order factor)	.88	301.65	109	2.76	.88	.89	.030	.061	.078
PPCK Scale (second-order factor)		241.70	110	2.2	.92	.91	.027	.055	.064
MRB Scale (first-order factor)	.84	1171.43	298	3.93	.69	.77	.045	.091	.10
MRB Scale (second-order factor)		742.15	298	2.49	.79	.82	.043	.084	.08

According to Table 3, the results of the CFA demonstrated that the second-order factor models fit the data significantly better than the first-order factor models. Because of this reason, the second-order factor models for scales were considered in the present study.

3. 2. The effects of demographic variables on MEA, PPCK, and MRB

The correlation ratio (eta-square, η^2) was calculated to interpret the effect of demographic variables on the dependent variable. The results of ANCOVA analysis are given in Table 4.

Table 4. *ANCOVA results for effects of demographic variables on MEA, PPCK, and MRB*

Scales	Demographic Variables	eta-square (η^2)
MEA Scale	Gender	.001
	Class	.017*
PPCK Scale	Gender	.00
	Class	.024*
MRB Scale	Gender	.00
	Class	.029*

*p <.05

As it can be seen from Table 4, the effect of class variable on MEA, PPCK and MRB variable is statistically significant. In all scales, fourth grade students (M_{MEA} = 4.19, SD_{MEA} = .032; M_{PPCK} = 4.12, SD_{PPCK} = .035; M_{MRB} = 3.93, SD_{MRB} = .025) scored higher than third grade students (M_{MEA} = 4.09, SD_{MEA} = .035; M_{PPCK} = 3.98, SD_{PPCK} = .039; M_{MRB} = 3.82, SD_{MRB} = .028) according to class variable. For this reason, the partial correlation analysis was performed to control the class variable. In addition, as Field (2009) stated, zero-order correlation analysis was conducted to understand that the relationships between MEA, PPCK and MRB variables did not change according to the possible effect of the class variable. The results of the partial and zero-order correlation coefficients are presented in Table 5.

Table 5. Partial and zero-order correlation coefficients.

Variable	M	SD	1	2	3
1.MEA	4.13	.37	-	.272*	.482*
2.PPCK	4.05	.41	.286*	-	.477*
3.MRB	3.87	.29	.496*	.488*	-

*p<.01; Zero-order correlation coefficients are below the diagonal. Partial correlation coefficients are above the diagonal

As shown in Table 5, zero-order correlation coefficients and partial correlation coefficients are close values. This shows that the class variable does not significantly change the relationships between MEA, PPCK and MRB. Therefore, demographic variables were not analyzed. While there is a positively low level relationship between MEA and PPCK (r = .286), there is a moderate positive relationship between PPCK and MRB (r = .488) with MEA and MRB (r = .496).

3. 2. The mediating role of the MRB

There are significant relationships between dependent and independent variables included in the research (in Table 5). Therefore important effects can be predicted among variables. Moreover, it was analyzed whether there is collinearity in the model to determine any multicollinearity problem. Tolerance and VIF values have confirmed that there is no multicollinearity between independent variables (Tolerans > .2, VIF< 10).

As Baron and Kenny (1986) noted, four criteria are required for a mediation analysis. These are in this study:

(a) independent variable (PPCK) should be related with dependent variable (MEA),

(b) independent variable (PPCK) should be related with mediator variable (MRB),

(c) by controlling independent variable (PPCK) in this equation, mediator variable (MRB) should be related with dependent variable (MEA),

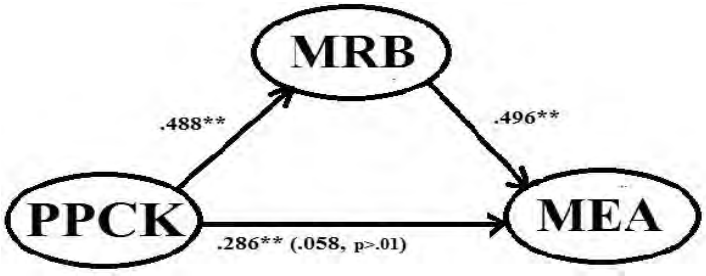
(d) when mediator variable (MRB) enters within the relationships of dependent variable (MEA) and independent variable (PPCK), this relation should either decrease significantly (partial mediating) or the relation should no longer be significant (full mediating).

Within the scope of mediation analysis, the relationship between independent variable PPCK and dependet variable MEA was analyzed in the first step. In the first step, PPCK was found to significantly affect MEA (β = .286, p<.01) (Table 6). In the second step, the effect of PPCK on MRB, whose mediating role was sought, was analyzed. As a result of the analysis it was determined that PPCK has significant effect on MRB (β = .488, p<.01). In this step, it is also seen in Table 6 that MRB significantly affects MEA (β = .496, p <.01). In the third step, PPCK and the mediated MRB were analyzed together and their effects on MEA were examined. As a result of this analysis, the effect of PPCK on MEA was not significant on being analyzed together with MRB (β=.058, p=.318>.01). The effect of MRB on MEA continued (β=.467, p<.01) (Table 6). According to the results of the mediation analysis conducted within the framework of criteria specified by Baron and Kenny (1986), MRB have a full mediating effect on the relationship between PPCK and MEA. The Sobel test was performed to confirm the full mediation effect. Sobel (z) was found significant (z=6.76, p<.01). This finding shows that MRB has the role of full mediating with the effect of PPCK on MEA. In this mediation model, indirect effect of MRB on PPCK and MEA was determined as β = .488 x .496 = .24 (Mediation Model, 2019). Finally, this mediation model is given in Figure 2.

Table 6. *Hierarchical regression analysis*

	MRB	**MEA**
Step 1		
PPCK β		**.286***
R^2		.082
Adjusted R^2		.079
F		**26.163***
Step 2		**MRB →MEA**
PPCK β	**.488***	**.496***
R^2	.239	.246
Adjusted R^2	.236	.243
F	**91.779***	**95.362***
Step 3		
PPCK β		**.058**
MRB β		**.467***
R^2		.248
Adjusted R^2		.243
F		**48.182***

*p< .01



** p<.01

Figure 2. *Mediating of MRB for PPCK and MEA*

4. Discussion and Conclusions

The aim of this study is to determine whether there is a mediating role of prospective mathematics teachers' beliefs about mathematics on the relationship between perceptions of pedagogical content knowledge and attitudes toward mathematics teaching. The relationships between variables were examined before determining this mediating role. It was determined that their perceptions of pedagogical content knowledge are an important predictor of attitudes toward mathematics teaching. In other words, high perceptions of prospective teachers about pedagogical content knowledge can increase their attitudes towards mathematics teaching positively. In addition, a significant relationship was found between the prospective mathematics teachers' beliefs about mathematics and their perceptions of pedagogical content knowledge. Moreover, there was a moderate positive relationship between their beliefs about mathematics and attitude towards mathematics teaching. This result is consistent with the results of studies of Göloğlu Demir (2011), Gülev (2008), Morgil, Seçken and Yücel (2004), Özkan, Tekkaya and Çakıroğlu (2002). In order to determine the mediation role of prospective mathematics teachers' beliefs about mathematics on the relationship between perceptions of pedagogical content knowledge and attitudes toward mathematics teaching, hierarchical regression analysis was performed to determine whether it meets the conditions suggested by Baron and Kenny (1986). As a result, it was determined that prospective mathematics teachers' beliefs about mathematics had full mediating role on the relationship between perceptions of pedagogical content knowledge and attitudes toward mathematics teaching. In other words, when prospective teacher has a higher perception of pedagogical content knowledge, her/his attitude towards mathematics teaching increases, and if this person has higher beliefs about mathematics, her/his perception of pedagogical content knowledge increases the effect on attitude towards mathematics teaching. Although there is no study which completely overlaps this finding in the literature, it was determined that self-efficacy beliefs of high school students is a mediating variable between attitude towards mathematics and math success (Randhawa, Beamer & Lundberg, 1993).

Depending on the results of this study it is quite important to analyze attitudes of prospective teachers towards the field in teacher training institutions. Because research shows that teachers' attitudes towards mathematics affect their students' attitudes towards mathematics (Leonard & Evans, 2007). Similarly, teachers' beliefs about mathematics affect their classroom practices and hence student achievement (Deng, 1995; Dede & Karakuş, 2014). Moreover it is also important to determine prospective teachers' perceptions about mathematic teaching and belief about mathematics and to investigate the relations between them before starting the profession. Because attitudes, beliefs and behaviors are formed over a long period of time, and cannot be changed easily and should be taken into consideration when training prospective teachers.

The study put forwards especially that when prospective teacher higher beliefs about mathematics, it would have a mediating effect on attitude towards mathematics teaching. This result demonstrates the necessity of carrying out studies for providing higher beliefs about mathematics in order to positively increase the attitudes of prospective teachers with a higher perception of pedagogical content knowledge. Understanding beliefs of prospective teachers about teaching is an important variable for

both in terms of increasing their professional development (Pajares 1992) and revising the lessons in teacher education. The study was based on quantitative method. Therefore, the use of quantitative and qualitative methods in future studies can be useful in understanding the relationships between variables. In future studies, new models that test the mediating effect of different variables can be developed. In addition, repeating the study in different education faculties and enlarging the sample may make the results of the study more generalizable.

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Authors

Berna CANTÜRK GÜNHAN, Dokuz Eylul University, Izmir (Turkey). E-mail: bernagunhan@gmail.com