

Full Length Research Paper

Turkish preservice mathematics teachers' mathematical values: Positivist and constructivist values

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The present study aimed to investigate preservice mathematics teachers' values toward their mathematics teaching with regard to their grade level, gender and departments. In the study, the positivist and constructivist values were used as value variables. Data were collected from 231 preservice primary and secondary mathematics teachers using a Likert-type questionnaire. Descriptive statistics were used to describe the demographic characteristics of the participants. Then, multivariate analysis was performed to determine the effects of department, gender and grade level on sub-dimensions of mathematics values. The results revealed that preservice primary and secondary mathematics teachers tend to adopt constructivist values rather than positivist values in the mathematics teaching. Teacher candidates' other values regarding mathematics are also presented.

Key words: Mathematical values, preservice mathematics teachers, values.

INTRODUCTION

Values are a general guide for the behaviors emerging from people's relations in the real life and their experiences (Raths et al., 1987). According to this, values are an integral part of human being and they play intentional or unintentional roles on individuals' behaviors, decisions and choices (FitzSimons et al., 2001). Matthews (2001) and Yero (2002) considered the values in the similar way, and saw them as the tools and the premises of the behaviors. For this reason, values are influential on teachers' decisions and behaviors (Fasheh, 1982). Similarly, Gudmundsdottir (1991) saw the values as a guide for teacher practice. On the other hand, Swadener and Soedjadi (1988) perceived the values as a concept or idea which is related to the worth of anything.

The relationships between values, beliefs, and attitudes

According to Herbel-Eisenmann et al. (2003), all individuals act on some form(s) of beliefs and values when they engage in work. These beliefs and values include both cognitive and affective dimensions. Attitude can be defined in very different ways, but, it interconnected with

interest, value, belief and opinion. None of these concepts can be directly observed and each of them needs to be inferred from behavior, speech or answers given to specially designed instruments (Leder and Forgasz, 2006). Values are more complex than attitudes and, concepts such as justice, symmetry and equality are typical examples of values. Beliefs are cognitive basis for attitudes and they provide information used in forming an attitude about any person or object (Koballa and Glyn, 2007).

Mathematics, mathematics teaching, and values

Mathematics is seen/ perceived as an abstract, cold and inhuman subject in the large societies. For that reason it is related to absolutist philosophies and is a profession and separated from values; that is, mathematics is value-free and culture-free. On the other hand, fallibilist philosophers opposed to this view of the absolutist philosophers and indicated that mathematics was consistent with "connected" values (Ernest, 1998).

However, they did not reject the role of mathematical structure, but refused the view that mathematics supports the unique, fixed and continuous hierarchical structure. In addition, contrary to absolutist philosophers, they also claim that mathematics is value-laden and culture-laden (Ernest, 1998, 2007).

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Education in general and mathematic education in particular portrays the values actively and transfers these values (Seah and Bishop, 2002; Seah, 2003a). Hence, two different view points related to mathematical philosophy given above have different effects on classroom practices (Ernest, 1991). In addition, values are crucially important parts of math learning and teaching (Seah, 2002). However, in spite of this, Clarkson and Bishop (1999) indicated that the importance of values is not very well known by math teachers. Furthermore values are not always positive. Hence, some values that teachers hold may well be quite detrimental to the teaching of (mathematics) that they undertake, as judged by others, although probably not judged in this way by the teachers themselves (Hill, 1991).

Bishop (1996) classified three types of values observed in the mathematics classrooms. They are general educational, mathematical, and mathematics educational values. Bishop (1998) indicated them as general educational values, honesty and good behavior. Bishop (2004) described three pairs of complementary mathematical values in the Western culture as (1) rationalism and objectism, (2) control and progress, and (3) openness and mystery. On the other hand, Bishop (2004) also conceptualized mathematics educational values as being formalistic view and activist view, instrumental understanding and relational understanding, relevance and theoretical knowledge, accessibility and special, evaluating and reasoning. According to this, educational values are related to general societal values, mathematical values are related to the scientific discipline of math and mathematics educational values are related to pedagogy of math, that is, to practices and norms emerging from math instruction (Seah and Bishop, 1999; Atweh and Seah, 2008). On the other hand, based on behavioral, cognitive constructivist approaches, Durmuş and Bıçak (2008) categorize the mathematical and mathematics educational values into two dimensions such as positivist and constructivist values. Positivist values put more emphasize on teaching math as teacher-centered, abstract and not relating math to the real life experiences. On the other hand, constructivist values put more emphasize on teaching math by using student-centered methods, concretely and relating it to real life experiences.

Purpose and rationale

Existing literature on mathematical values in Turkey revealed a few studies examining preservice teachers' mathematical values (Durmuş and Bıçak, 2006; Durmuş et al., 2007). In addition, there is a limited number of studies which investigated the status and the importance of values in math teaching (Dede, 2007a), the values conveyed through math textbooks in Turkish primary and high schools (Dede, 2006a, b) and preservice math teachers' values toward a specific math concept (Dede,

2006c). On the other hand, the studies on mathematics teachers' (or preservice math teachers) mathematical and mathematics educational values are getting more attention in world literature (see the Australian VAMP and the Taiwanese VIMT projects). These studies have revealed math teachers' (or preservice math teachers) values and how these teachers explicitly or implicitly convey their values into their classroom environment or why math teachers could not hold values (Lin et al., 2006). Mathematics is a culture (Butty, 2001) or "mathematics, conceived of as a cultural product, which has developed as a result of various activities" (Bishop, 1988). So, the approaches towards mathematical studies vary in terms of communities, cultures and time (Lancaster, 2006). Thus, the present study aimed at answering the following research questions:

1. What are the preservice mathematics teachers' mathematical values?
2. Do preservice mathematics teachers' mathematical values differ with regard to department, grade levels, and gender?

MATERIALS AND METHODS

Research design

This study was designed as descriptive survey research. The research data were collected through a survey questionnaire including items on a Likert type scale in order to ascertain the preservice math teachers' mathematical values. It is carried out to gather information on how people think about a certain issue, in this case, about their own mathematical values (Rosnow and Rosenthal, 1996). It is appropriate for collecting descriptive data, as it tries to describe, because, in descriptive model, the features are found out to be as their original forms (McMillan, 2000). This research showed the mathematical values (including positivist and constructivist values) held by preservice primary and secondary mathematics teachers.

The mathematics curriculum includes both implicit and explicit values. Therefore, implicit values were presented in a hidden manner, acquired in more subtle ways, and evidenced in the learner's behavior. The explicit values were planned explicitly, applied in the classrooms, and acquired from the instruction (Bishop et al., 2001; Lim and Ernest, 1997; Seah et al., 2001). In the present study, the explicit values stated by the teachers and to be acquired by learners have been documented using a questionnaire. Therefore, the definition of value used in this present study can be considered as personal preferences for stating if a thought and statement are of importance and worthwhile for the individual.

Participants

In Turkey, Education Faculties were partially re-established based on the constructivist approach, and the Mathematics Education program was divided into two groups as primary and secondary as a result of accreditation studies undertaken at higher education in 1997 (Higher Education Council, 1998). The period has been planned as four years for Primary Mathematics Education programme, while Mathematics Education Degree Studies program has been increased from 4 - 5 years for Secondary Mathematics Education Program as 3.5 years + 1.5 years. During 3.5 years

Table 1. Demographic preservice mathematics teachers' profile.

	Preservice Primary Mathematics Teachers		Preservice Secondary Mathematics Teachers	
	Number of Math Teachers	Percent	Number of Math Teachers	Percent
Grade Level				
Freshman	52	32.9	30	41.1
Senior	106	67.1	43	58.9
Total	158	100	73	100
Gender				
Female	79	50	35	47.9
Male	79	50	38	52.1
Total	158	100	73	100

Discreet Mathematics, Analytic Geometry, Linear Algebra, Differential Equations, Differential Geometry, Topology, Introduction to Algebra, and Elementary Number Theory) generally at Faculty of Science and Literature. During remaining 1.5 years program, the students study subject-related pedagogical courses (that is, Introduction to Teaching Profession, School Experience, Special Teaching Methods I, Computer Assisted Mathematics Teaching, Guidance, Special Teaching Methods II, and Mathematics Course book Evaluation and Practice Teaching) at Faculty of Education. The participants of the study took both the abstract side of math and the concrete side of the teaching of mathematics. Of the participants, preservice math teachers also took pedagogical courses that are Instructional Planning and Evaluation, Instructional Technology and Materials Development, and Classroom Management. On the other hand, preservice secondary mathematics teachers took pure math courses. The credits of subject matter courses (for example, General Mathematics, Discreet Mathematics, Linear Algebra, Introduction to Algebra, and Elementary Number Theory) in a week is higher than those in primary math program. For this reason, the contents are more detailed. In addition, the courses such as Differential Geometry, Topology, Complex Functions Theory, Numerical Analysis, Complex Functions Theory and Real Analysis are only included in Secondary Mathematics Education.

High school graduates are placed to the universities based on their university entrance exam (OSS) results. In recent years, both Secondary and Primary Mathematics Education programs have received higher attention as the most preferable programs by the candidates/high school graduates. This situation let more qualified/outstanding students enter these programs. The math teachers who are graduated either from Secondary or Primary Mathematics Education program, will work as a math teacher, inspector or supervisor in public and private schools. This study was limited with determining preservice primary and secondary math teachers' mathematical values. For the present study, 158 (79 female, 79 male) preservice primary math teachers and 73 (35 female, 38 male) preservice secondary math teachers were invited. Fifty two of preservice primary math teachers and 30 preservice secondary math teachers are freshman whereas 106 of preservice primary math teachers and 43 preservice secondary math teachers are senior. Table 1 summarizes the characteristics of the participants.

Instrument and procedure

A five-point Likert type scale developed by Durmuş and Bıçak (2006) was used for data collection. Developers of the instrument

found two-factor solution from a principal component factor analysis. There were (1) positivist values and (2) constructivist values. Cronbach's alpha reliability coefficient was found 0.73 for whole instrument, 0.64 and 0.74 for each factor respectively. The instrument was administered to 231 preservice mathematics teachers who were randomly selected in a four-year teacher education program at the Primary Mathematics Education and in a five-year teacher education program at the Secondary Mathematics Education Department of one university in Turkey during the spring semester of 2007 - 2008 academic year. It took about thirty minutes to complete the questionnaire. The purpose of the study was clearly explained to the participants in each class by the researcher. Furthermore, the researcher ensured the confidentiality of the responses given by preservice math teachers. Sample items drawn from each factor in the questionnaire are given in Table 2.

Data analysis

Descriptive statistics (that is, mean, standard deviation and percentage) were used to describe the demographic characteristics of the participants. Furthermore, in order to examine the effects of department, gender and grade level on sub-dimensions (positivist values and constructivist values) of math values, the inferential method of multivariate analysis of variances was performed through the making use of Statistical Package for the Social Sciences (SPSS 17.0) software. Both interaction effect and main effects at 0.05 significance level were examined.

RESULTS

R.Q.1. What are the preservice mathematics teachers' mathematical values?

As observed in Table 3, the mean score obtained from the sub-dimension of constructivist values ($M = 3.61$, $SD = 0.43$) was observed to be higher than the mean score obtained from positivist values ($M = 2.91$, $SD = 0.46$). The result showed that preservice mathematics teachers tended to adopt constructivist values much more than positivist values in mathematics teaching.

As observed in Table 4, as for primary freshman and senior math students, the mean scores obtained from the sub-dimension of constructivist values ($M = 3.71$, $SD = 0.38$; $M = 3.62$, $SD = 0.42$) were higher than the mean

Table 2. Sample items for each factor of the questionnaire.

Factor	Item Number	Sample Item
Pozitivist values	3	New subjects in mathematics cannot be learned without knowing previous subjects.
	7	Mathematics can be understood only by people who are clever.
	17	Teacher centered activities are essential in mathematics teaching.
Constructivist Values	16	Mathematics has a vital role on the development of civilizations.
	24	In mathematics teaching, activities should be designed in a way that students are actively involved.
	27	Teachers and students should construct mathematical knowledge together.

Table 3. Descriptive statistics of the values of preservice math teachers.

Value	Mean	SD	N
Constructivist	3.61	0.43	231
Positivist	2.91	0.46	231

Table 4. Descriptive statistics of the values of preservice math teachers in terms of their departments.

Value	Department											
	Preservice Primary Teachers						Preservice Secondary Teachers					
	Freshman			Senior			Freshman			Senior		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Constructivist	3.71	0.38	52	3.62	0.44	106	3.59	0.44	30	3.46	0.43	43
Pozitivist	2.96	0.45	52	2.82	0.50	106	3.17	0.36	30	2.87	0.36	43

Table 5. Descriptive statistics of the values of preservice math teachers in terms of their grade levels.

Value	Grade Level					
	Freshman			Senior		
	Mean	SD	N	Mean	SD	N
Constructivist	3.69	0.40	82	3.57	0.44	149
Positivist	3.04	0.43	82	2.83	0.46	149

scores for positivist values ($M = 2.96$, $SD = 0.45$; $M = 2.88$, $SD = 0.50$) respectively. Similarly, as for secondary freshman and senior math students indicates the mean scores for constructivist values ($M = 3.59$, $SD = 0.44$; $M = 3.46$, $SD = 0.43$) were higher than the mean scores of positivist values ($M = 3.17$, $SD = 0.36$; $M = 2.87$, $SD = 0.36$) respectively. In addition, primary freshman and senior math students seemed to adopt more constructivist values ($M = 3.71$, $SD = 0.38$; $M = 3.62$, $SD = 0.44$) than secondary freshman and senior math students ($M = 3.59$, $SD = 0.44$; $M = 3.46$, $SD = 0.43$) respectively.

As shown in Table 5, the mean scores of freshman and

senior math students for the sub-dimension of constructivist values ($M = 3.69$, $SD = 0.40$; $M = 3.57$, $SD = 0.44$) was higher than their means scores for positivist values ($M = 3.04$, $SD = 0.43$; $M = 2.83$, $SD = 0.46$) respectively. On the other hand, as also given in Table 5, freshman math students seemed to have more positivist values ($M = 3.04$, $SD = 0.43$) than senior math students ($M = 2.83$, $SD = 0.46$).

As given in Table 6, the mean scores of preservice female and male teachers for the sub-dimension of constructivist values ($M = 3.68$, $SD = 0.42$; $M = 3.55$, $SD = 0.43$) were higher than the mean scores for positivist

Table 6. Descriptive statistics of the values of preservice math teachers in terms of their gender.

Value	Gender					
	Female			Male		
	Mean	SD	N	Mean	SD	N
Constructivist	3.68	0.42	114	3.55	0.43	117
Positivist	2.95	0.46	114	2.87	0.46	117

values ($M = 2.95$, $SD = 0.43$; $M = 2.87$, $SD = 0.46$) respectively. The mean score of preservice female math teachers on constructivist and positivist values ($M = 3.68$, $SD = 0.42$; $M = 2.95$, $SD = 0.46$) were higher than the mean score of the preservice male math teachers ($M = 3.55$, $SD = 0.43$; $M = 2.87$, $SD = 0.46$) respectively.

R.Q.2. Do preservice mathematics teachers' mathematical values differ with regard to department, grade levels, and gender?

The multivariate analysis of variance results indicated that the interaction effect of the department-grade level-gender on the two dependent variables of positivist values and constructivist values was insignificant with a very small effect size (Wilks' Lambda $F = 0.074$, $p > 0.05$, *eta squared* = 0.001). However, it was concluded that there was not enough evidence to explain the insignificant effect of a three-way multivariate interaction. Similarly, the two-way interaction effects of department-gender and department-grade level on both dependent variables were insignificant with small effect size, respectively (Wilks' Lambda $F = 0.098$, $p > 0.05$, *eta squared* = 0.012; Wilks' Lambda $F = 0.992$, $p > 0.05$, *eta squared* = 0.008), but the interaction effect of grade level-gender was found significant with small effect size (Wilks' Lambda $F = 3.63$, $p < 0.05$, *eta squared* = 0.032). Tests of between-subject effects indicated that the effect of grade level-gender on one of the dependent variables was significant with small effect size ($F(1, 223) = 6.98$, $p < 0.01$, *eta squared* = 0.030). After finding this significant result, follow-up test was conducted to examine pair-wise differences. In constructivist values estimated marginal means were 3.49 ($SD = 0.07$) for male freshman math students, and 3.79 ($SD = 0.066$) for female freshman math students. Pairwise comparisons showed that female freshman math students scored significantly higher in constructivist values than did male freshman math students.

The results also revealed that the main effect of gender was insignificant with small effect size (Wilks' Lambda $F = 2.917$, $p > 0.05$, *eta squared* = 0.026), but the main effect of department and grade level on both sub-dimensions were significant with small effect size respectively (Wilks' Lambda $F = 5.481$, $p < 0.01$, *eta squared* = 0.047; Wilks' Lambda $F = 5.571$, $p < 0.01$, *eta squared* = 0.048). It can be said that there was enough evidence to affirm that there was an effect of department

on the variables positivist values ($F(1, 223) = 4.056$, $p < 0.05$, *eta squared* = 0.018) and constructivist values ($F(1, 223) = 4.156$, $p < 0.05$, *eta squared* = 0.018). This results suggested that here was enough evidence to say that there was an effect of grade level on positivist values ($F(1, 223) = 10.492$, $p < 0.01$, *eta squared* = 0.045). After finding this significant result, follow-up test was conducted to investigate pair-wise differences. In positivist values estimated marginal means were 3.06 ($SD = 0.05$) for freshman math students, 2.85 ($SD = 0.04$) for senior math students. Pairwise comparisons showed that freshman math students scored significantly higher in positivist values than did senior math students. On the other hand, estimated marginal means in positivist values were 2.89 ($SD = 0.04$) for the preservice primary math teachers, and 3.02 ($SD = 0.05$) for the preservice secondary math teachers. Pairwise comparisons indicated that preservice secondary math teachers scored significantly higher in positivist values than did preservice primary math teachers. However, in constructivist values estimated marginal means were 3.65 ($SD = 0.03$) for preservice primary math teachers, and 3.53 ($SD = 0.05$) for preservice secondary math teachers. Pairwise comparisons revealed that preservice secondary math teachers scored significantly lower in constructivist values than did preservice primary math teachers.

DISCUSSION

The results of the present study showed that the freshman and senior students held constructivist values rather than positivist values for the mathematics teaching. The reason may be due to the fact that senior math teaching students took their classes in planned and orderly during their university education, whereas freshman math teaching students took their classes disorderly based on constructivism during their elementary and high school education (Dede, 2007b). Because, in Turkey, based on the results obtained from the national reports and international comparative studies such as TIMSS and PISA, The Board of Education and Ministry of National Education together initiated a reform attempt in the primary and secondary school mathematics curricula designed in line with the constructivist approach. New mathematics curricula were put into action during the

academic year of 2005-2006 for grades 1-5 and 2006-2007 for 6th grades, and gradually for other grades. However, this process did not cover the participants of the present study. Freshmen student teachers in the study were partially trained by the teachers who were graduated from the universities where the education has been dependent on constructivism. Because accreditation of Educational Faculties based on constructivist approaches was started in 1997 (accreditation of primary schools and high schools was started 10 year before) and these revisions have continued in the following years (2006 and last revision was done in 2007). Shortly, constructivist approaches have recently been so popular in Turkey (Boz, 2008). The other results of the present study also supported this situation. For example, freshman math students found the positivist values significantly more important for math teaching than did senior math students. The other example is that preservice primary math teachers gave significantly more emphasize on constructivist values for math teaching and less emphasize on positivist values when compared with preservice secondary math teachers. It is believed that the teaching in Faculty of Education where the study was undertaken may have an impact on this result, because, as mentioned earlier, preservice primary math teachers stay within the context of their Faculty of Education during their 4 years education and trained by the academic staffs who hold and internalize the constructivist approaches. On the other hand, the education of preservice secondary math teachers is realized in two steps as indicated earlier (3.5 years in Science and Literature Faculty and 1.5 years in Education Faculty). In Turkey, the academic faculty member of Science and Literature Faculties generally accept positivist values for their instruction. Because, the main mission of these faculties is anticipated to conduct "basic research" (Higher Education Council, 1998, p.16) or "scientific and basic research" (Şimşek, 2005, p.1) (Note: Higher Education Council - YÖK is a responsible body for planning, implementation, and coordination of higher education in Turkey). Similarly, the findings of VAMP Project supported the findings given in the present study in that primary math teachers more emphasized educational, spiritual or moral values in their instructions than did secondary math teachers (Bishop, 2004). Also, in line with the explanation above, the instructions designed based on constructivist approach has an impact on shaping preservice math teachers' mathematical values as well as on beliefs (Boz, 2008). In fact, in general manner, values can be considered as the practice of beliefs. In other words, for example, math teachers' values are connected with their beliefs in their instructions. It is the indicator of how much practice is carried out in the class environment (Clarkson et al., 2000). In addition, this is an important result when it is considered that the change in the acquired values is quite hard compared with attitudes and beliefs (Seah, 2003b). Because, preservice math teachers who adopt constructivist approaches consider these approaches for

constructivist approaches consider these approaches for his/her instruction more valuable, s/he will transfer these adoption and consideration to the students explicitly or implicitly in the future (Clarkson et al., 2000). On the other hand, in the present study, the effect of gender on mathematical values (both constructivist and positivist) was found to be statistically insignificant. Durmuş et al. (2007) found also no significant effect of gender on both constructivist and positivist values. However, in the other study done by Durmuş and Bıçak (2006), male math students scored significantly higher in positivist values than female math students did. In addition, in the present study, the interaction effect of grade level-gender on constructivist values was statistically significant. Furthermore, female freshmen students scored significantly higher in constructivist values than male freshman math students did. The reasons of this situation can be a topic of another research study which will be designed as qualitatively. For example, why math is generally considered as a male topic/subject (Fennema and Sherman, 1976; Forgasz et al., 1999; Forgasz, 2007) and why male freshman students much more adopt positivist values can be examined in the future studies.

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