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An Investigation Related to the Modelling Levels and Values of Elementary School Prospective Mathematics Teachers

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Abstract

With the discussions on the nature of mathematics, mathematics is regarded as a value laden area. That it contains a wide range of values has led to consideration of new approaches in classroom practices. The modelling approach which also includes traditional problem solving is consistent with different values of mathematics. With the recognition of mathematics that has different values with the traditional values, mathematics teacher training programs need to be addressed again. It has been intended to contribute the implementation of the program by examining the profiles of prospective mathematics teachers in the current state and the views for modelling. The profiles and modelling levels of 136 prospective mathematics teachers who study in mathematics teacher training programme at Abant Izzet Baysal University in 2008-2009 and 2009-2010 academic years have been analyzed. When the participants' levels of having positivist values and levels of having constructivist values were compared, a significant difference was determined in favor of constructivist values. When the values were analyzed in terms of gender variable, the female participants' levels of having constructivist and positivist values showed a significant difference in favor of constructivist values. Modelling levels were examined in different dimensions, and it was determined significant differences between sub-dimensions. In terms of gender variable, when sub-dimensions of each modelling levels were analyzed, there was no significant difference between female and male prospective mathematics teachers. Also, there was a positive correlation between values and modelling levels among prospective mathematics teachers.

Key Words

Values in Mathematics, Constructivist Value, Positivist Value, Modelling, Prospective Mathematics Teachers.

Although mathematics and mathematics teaching are different study fields, the nature of mathematics and application of mathematics to mathematics teaching are inseparable complements. Mathematics just like many other fields interacts with social sciences such as psychology, sociology, and philosophy (Bishop, 2000). In addition, there are many examples of these interactions in the history of mathematics (Davis & Hersh, 2002). This new perspective on the nature of mathematics requires us to reconsider teaching mathematics (Ernest, 2007). In this context, two points are raised as the starting point of this study: Values in mathematics and modelling approach. Whereas values are about what is attached importance to in teaching mathematics, modelling is about how to approach teaching mathematics.

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Values in Mathematics Education

While beliefs are mostly about true/false kinds of views and judgments, values correspond to significant/insignificant kinds of views and judgments (Chin & Lin, 2001; Jorgensen & Ryan, 2004; Seah, Bishop, FitzSimons, & Clarkson, 2001). Values di-

rectly affect learning (Gedik, 2010). Hence, values should be taken into consideration in mathematics (Matthews, 2001). Indisputability of corollaries in mathematics is related to assumptions (axiom and series of theorems based on it) which are made during the process. This leads to the acceptance of them in terms of values (in an unquestionable way). However, when the values such as accuracy and fallibilism are investigated in the context of mathematics, it can be concluded that it is similar to the results in social sciences (Bishop & Clarkson, 1998; Bishop & Seah, 2002; Ernest, 1998, 2004; Glas, 1998). The accuracy of mathematical knowledge together with fallibilism calls forth questioning common knowledge in mathematics. Thus, the research on the nature of mathematics is directed towards this subject (Baki, 2008; Bishop, 2000; Brown, 1999; Chin & Lin, 2001; Dede, 2010; Ernest, 1998, 2004; FitzSimons, Bishop, Seah, & Clarkson, 1999; Glas, 1998; Seah, Bishop, FitzSimons, & Clarkson, 2001).

For this reason, the research on both prospective mathematics teachers and mathematics teachers need to be implemented to determine the values and their relationship on teaching learning process. FitzSimons, Bishop, Seah and Clarkson (1999), after determining the values that teachers have, examined how teachers reflect their values to classroom environment. An important result of this study is that teachers overtly or covertly reflect their values in their teaching. While teachers do teaching activities according to their values, sometimes their activities contrast with their values (Pekince, 2010; Sosniak, Ethington, & Valeras, 1991). In another research on prospective teachers, values of prospective teachers and how they are implemented into classroom are examined (McGowen & Gary, 2001). One of the results of this study is that it is harder to change the values of prospective teachers than to teach new mathematical formulas to the prospective teachers. Prospective teachers constantly keep referring to the values, that they are used to, and have difficulty accepting new ones.

Modelling

In traditional problem solving process, basically a linear way from the given to the goals is followed. The complicated structure of doing mathematics requires the revision of the perspective towards problem solving (Bonotto 2007; Doerr & English, 2003; Thomas & Hart, 2010). In fact, activities requiring modelling instead of problem solving draw attention due to their dynamic and multi-faced features (Crouch & Haines, 2004; Doerr & Lesh, 2003; Kaput, 1987; Korkmaz, 2010; Lesh & Doerr, 2003a; Lester & Kehle, 2003; Taşova & Delice, 2010). In the study of Kertil (2008) in which the problem solving skills of prospective mathematics teachers in modelling process was analyzed, it became clear that the ability of prospective teachers' problem solving skills was found to be insufficient. Another result of the mentioned study was that prospective teachers were not familiar with modelling activities, but if they get enough experience, modelling activities help them enhance their problem solving perspectives a lot. As the rich potential modelling in different studies shows, a lot of countries have begun to include modelling in their curricula (Australia Ministry of Education, 2008, Department for Education and Employment, 1999; Lingefjärd, 2002a; Milli Eğitim Bakanlığı [MEB], 2004, 2005; National Council of Teachers of Mathematics [NCTM], 2000).

As the mismatch between the structure and the process the model represents cause changes, the trial of the match of model with the situation is an important step in modelling (Durmuş & Kocahülah, 2006). Thus, modelling has a cyclic structure: defining, manipulating, transforming, predicting and confirming (Lesh & Doerr, 2003b, p. 17)

The dynamic and rich content that modelling will bring to mathematics teaching has attracted the attentions of many researchers (Çoban, 2009; Doruk, 2010; English & Watters, 2004; English & Watters, 2004; Eraslan, 2010; Güneş, Gülçiçek, & Bağcı, 2003; Güzel & Uğurel, 2010; Justi & Gilbert, 2002; Kaf, 2007; Zbiek & Conner, 2006). How students use informal and personal information was observed, and it was found out that this information would help them in modelling process and make writing reports easier for them. There are different studies done with the prospective mathematics teachers, though limited (Eraslan, 2011; Lingefjärd, 2002b; Lingefjärd, & Holmquist, 2005; Verschaffel, De Corte, & Borghart, 1997). Prospective teachers expressed that activities requiring modelling require higher level of thinking and include different features than problem solving in which different perspectives lead to different results. In view of prospective mathematics teachers who were raised according to the traditional viewpoint of mathematics, it is not easily accepted not to be able to find a 'one' definite answer in modelling activities. It is a significant matter that prospective mathematics teachers should have an awareness about the typical values of mathematics and teaching approaches consistent with these values in their education in

the process of their training. This study aims to shed light on other researches constructing a profile of values which prospective mathematics teachers have, specifying the awareness level oriented to different dimensions of modelling and analyzing the relationship between possessed values and the modelling levels. As suitable for the purposes mentioned, the following questions will be investigated:

1. Is there a statistically significant difference between the values which prospective mathematics teachers have?

2. Is there a statistically significant difference according to the gender of prospective mathematics teachers in terms of possessed values?

3. Is there a statistically significant difference between the levels of modelling which prospective mathematics teachers have?

4. Is there a statistically significant difference according to the gender of prospective mathematics teachers in terms of modelling levels which prospective mathematics teachers have?

5. Is there a statistically significant relation between values and modelling levels which prospective mathematics teachers have?

Method

This study is a survey research owing to the fact that prospective mathematics teachers' point views have been tried to be analyzed without any effects from the outside to the conditions of the situation at hand (Karasar, 2000).

Instruments

For the purpose of data collection, Mathematics and Mathematics Educational Values Scale developed by Durmuş and Bıçak (2006) has been applied in the scope of this study. This scale consists of 34 items designed in 5-point Likert-type for the purpose of revealing the prospective mathematics teachers' values. Models and Modelling Questionnaire developed by Güneş, Gülçiçek and Bağcı (2004) has been used to reveal the point of views of prospective mathematics teachers about models and modelling. This questionnaire has been developed to reveal the views of Science and Mathematics teachers about model and modelling. When the items in the questionnaire are taken into consideration, it can be seen that some ideas arising in the literature oriented to model and modelling are reflected. The questionnaire consists of 30 items designed in 5-point Likert-type scale.

Data Analysis

The acquired data have been processed with the help of a statistics software. Appropriate statistical techniques have been operated to answer the research questions.

Results

When the average values pertaining to participants' positivist values were examined, it was seen that they were on "undecided" level ($\overline{X}$=2.83), and the average values pertaining to their constructivist values were seen that they were on "I agree" level ($\overline{X}$=3.60). When the levels of participants having positivist values and the levels of their having constructivist values were compared, there was a significant difference in favor of the constructivist values. In terms of the gender variable, when the participants having positivist values were compared, the male prospective mathematics teachers were more positivist than female prospective mathematics teachers. The result showed that there was no significant difference among the modelling levels of the participants. In order to determine among which groups there was significant difference, Scheffe's Test was performed. According to the results of this test, it was determined that the significant differences were between seeing models as multi-representations ($\overline{X}$=3.73) and models as accurate copies ($\overline{X}$=3.20) in favor of models as multi-representations; between seeing models as multi-representations and models as explanatory tools ($\overline{X}$=4.00) in favor of models as explanatory tools; between seeing models as accurate copies and models as explanatory tools in favor of models as explanatory tools; between seeing models as accurate copies and use of scientific models ($\overline{X}$ =3.62) in favor of use of scientific models; between seeing models as accurate copies and change of structure of models ($\overline{X}$=3.89) in favor of change of structure of models; between seeing models as accurate copies and model examples ($\overline{X}$=3.60) in favor of model examples; between seeing models as explanatory tools and use of scientific models in favor of seeing models as explanatory tools; between seeing models as explanatory tools and model examples in favor of seeing models as explanatory tools; between use of scientific models and change of structure of models in favor of change of structure of models, and between change of structure of models and model examples in favor of change of structure of models.

One of the results of the study indicated that there was significantly positive relationship between the

levels of participants having positivist values and modelling sub-dimensions which were model examples and accurate copies. Besides, it was pointed out that there was a significantly positive relationship between the levels of participants having constructivist values and modelling sub-dimensions which were models as explanatory tools and use of scientific models.

Discussion

When the positivist and constructivist values that participants have were compared, it was clear that there was a considerable variation in favor of constructivist values. Renewed elementary school mathematics curricula included significant changes (Kuş, 2009; MEB, 2004, 2005). These changes were reflected in course books, and the values included in course books were analyzed by Dede (2006). Some of the changes among the mentioned above were as follows: It is important to construct knowledge by the teacher and the students together, the teacher needs to facilitate the process of the work as well as the result, and mathematics should be no longer regarded as a working area which consists of unquestionable, independent, and certain facts (Boz, 2008). Accordingly, there have been some changes in teacher training programmes. Courses such as Philosophy of Mathematics and History of Mathematics have been added to the teacher training programmes. Furthermore, each university aims to contribute to the process of training teachers by increasing elective courses depending on the number of instructors. Dede (2009) found that the level of primary school and secondary school prospective mathematics teachers' rate of accepting constructivist values were higher than positivist values. There was no significant difference among the teachers in terms of gender who had constructivist values. On the other hand, it was noticed that the level of having positivist values of prospective male teachers was higher than the prospective female teachers' values. It can be concluded that the reason why the level of having positivist values of prospective male teachers is higher than the prospective female mathematics teachers' values is that there is a male dominant approach both culturally and historically towards the nature of mathematics, and this approach is traditionally close to positivist values (Barkatsas, Forgasz, & Leder, 2001; Davis & Hersh, 2002; Forgasz, Leder, & Gardner, 1999).

The reason why there is no significant difference among male and female prospective mathematics students can be considered that constructivism has the potential to remove the gender factor in perception of mathematics.

The interaction between among sub-dimensions is expected situation because the process of modelling and the models are complex. There is a respectively difference between the level of viewing models as multi-representations and the level of viewing models as accurate copies on behalf of the latter one. When the items of questionnaires aimed to determine the level of viewing models as multi-representations were observed, it was found that there were expressions in relation with the variety of models and productiveness of models. However, it was aimed to determine the level of participation with the expressions in the questionnaires aimed to find out the views of the models restricted and narrow scoped in viewing the models as accurate copies (Grosslight, Unger, Jay, & Smith, 1991). The models in the study of Berber and Güzel (2009) with prospective teachers were seen multi-representations, not as accurate copies. Viewing the models as multi-representations shows us that participants have a wide view of models in this study.

The reason why there is no significant difference between male and female prospective mathematics teachers can be considered that constructivism has the potential to reveal the gender factor in perception of mathematics.

Because of the fact that models and modelling process are complex, it is expected situation to have interaction among sub-dimensions. When the state of models seen as multi-representations and the state of models seen as accurate copies are compared, a significant difference was found in favor of model seen as multi-representations. When the scale items of models seen as multi-representations were analyzed, statements were about the diversity and productiveness of the models. Unlike these items, when the scale items of models seen as accurate copies were analyzed, it was aimed to reveal the acceptance levels of participants to models in terms of their limited features. In the study of Berber and Güzel (2009) with the prospective teachers have also been accepted as multi-representations rather than copies. In this study, the state of models' being seen as multi-representations shows that the participants have a broad point of view on the models. When all sub-dimensions were considered, it was concluded that the participants could reason the models with their most general meaning; they could determine model examples correctly and could make appropriate choices among them. Hence, it can be concluded that models and

modelling activities offer a rich content and the prospective teachers have a clear idea about models and modelling. It can be said that the participants have acquired this extensive comprehension during their undergraduate education as primary school mathematics teaching program aims. The fact that the education the prospective teachers have about the models and modelling during their education process has a positive effect on their modelling levels was shown to be true by Keskin's (2008) study with primary school prospective teachers.

No significant difference has been found between the prospective mathematics teachers' six different modelling states and gender variable. It has been found out that the participants perceive the models and modelling in a similar way without gender difference.

It can be said that the traditional approaches of the participants who have positivist thoughts intended for mathematics can restrict the rich possibilities the modelling offers. Kertil's (2008) study which revealed that the traditional problem solving abilities were insufficient in modelling process confirmed that result.

When all sub-dimensions of modelling are compared, there are positive relations that support the model and modelling as to be thought as a whole. Critical approaches towards the nature of mathematics affect the way mathematics and its education are seen. By considering that mathematics is also seen as including specific values like social sciences, models and modelling approaches have the potential of enriching teaching mathematics (Blum, Galbraith, Henn, & Niss, 2007; Bonotto, 2010; Clarkson, FitzSimons, Bishop, & Seah, 2000). The possibilities of models and modelling need to be analyzed with teacher education, prospective teaching training and studies towards in-class applications for different levels and subjects.

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