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Pre-service Elementary Mathematics Teachers' Views on Model Eliciting Activities

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Abstract

The aim of this study is to investigate the views of pre-service elementary mathematics teachers on model eliciting activities and the nature of mathematics and of doing mathematics via MEAs after experiencing four model-eliciting activities in a 14 week "Modeling in Teaching Mathematics Course" offered as an elective course at a major university in Ankara, Turkey. For this purpose, a focus group interview was conducted with nine pre-service elementary mathematics teachers. The interview took about an hour and video-recorded. Findings indicated that pre-service elementary mathematics teachers have positive views on model eliciting activities in learning and teaching elementary school mathematics.

Keywords: mathematical modeling, model eliciting activities, pre-service elementary mathematics teachers

1. Introduction

Models and modeling (M&M) perspective of mathematical thinking and learning gained greater attention with the reform movement in education began in 2005, in Turkey. M&M perspectives focus on the development of knowledge, conceptual tools, and/or models in order to make decisions to solve complex, real-life problems (Lesh & English, 2005). These models and/or conceptual tools are "powerful (for some specific purposes), sharable (with other people) and reusable (beyond the context in which they were developed)" (Lesh & English, 2005, p. 488).

Model-eliciting activities (MEA)s are meaningful and interesting thought-revealing (Lesh, et al., 2000) activities that require students to express and adapt their current ways of thinking in order to interpret and develop useful tools/models to solve the complex, real-life problem situations. During the solution of MEAs, students go through the iterative modeling cycles which involve four nonlinear steps of interacting processes: description, manipulation, prediction, and verification (Lesh & Zawojewski, 2007). Description involves students' mapping from the real world to the modeled world. Then students manipulate the mathematical model and generate predictions related to the original problem they aim to solve in the real world. Finally they verify the model by checking the usefulness of their predictions in the context of real world. Students often express, test, and revise their trail solutions during these iterative processes.

MEAs are mainly used in mathematics education to understand and assess student thinking and to teach mathematical concepts. With the curricular changes in Turkey, both teachers and pre-service teachers are introduced

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to modeling perspective in math education through seminars, training programs and courses. We, however, know little about the teachers' and pre-service teachers' perceptions about using models and adopting modeling perspective in their classrooms. Research has shown that both in-service and pre-service teachers have difficulties in understanding M&M perspective and using MEAs in their mathematics classrooms (Bukova-Güzel, 2011; Eraslan, 2011; Kayhan-Altay, et al., 2012; Turker, et al., 2010; Yu & Chang, 2009). Yu and Chang (2009) worked with sixteen secondary mathematics teachers' attended in a nine week course linked to a Master's degree program in education. Participants were asked to engage in three MEAs throughout the course and then to design one MEA as a group. Results showed that teachers developed positive attitudes towards MEAs in teaching mathematics since they are related to real life and include open-ended problems that are promoting students' mathematical thinking and communication skills. On the other hand, teachers were concerned about making connections between MEAs with the current math curriculum and the entrance exams of schools. They also pointed out the challenges of applying MEAs in real classroom settings in terms of managing the class discussion and adjusting time for students to engage in MEAs.

Research conducted with pre-service teachers in Turkey revealed similar results. Bukova-Güzel (2011) examined secondary pre-service mathematics teachers' approaches as they construct and solve mathematical modeling problems. During the elective mathematical modeling course, teacher candidates were introduced modeling perspective and worked on MEAs. As a requirement of the course, six groups of pre-service teachers were asked to first construct mathematical modeling problems and then solve the problems they constructed. Results have shown that pre-service teachers constructed MEAs by taking into account several criteria such as suitability to real life and to students' existing mathematical knowledge. With regard to solving MEAs they constructed, pre-service teachers were able to understand and simplify the problem situation, whereas they had difficulty in interpreting and validating the findings revealed through the model. Likewise, Türker, et al. (2010) examined elementary and secondary pre-service mathematics teachers' performances at MEAs and their views on these activities. They asked 60 participants to solve four MEAs individually at four sessions. Findings showed that pre-service teachers were more successful on the activities that involved the most numerical data. Furthermore, interviews with four participants demonstrated that pre-service teachers found the activities challenging and different from the ones they had encountered before. They also expressed that the skills to form a mathematical model and solve a real life problem through the model could be developed through training. Likewise, Eraslan (2011) examined prospective elementary mathematics teachers' perceptions on MEAs after they took an elective course related to modeling in mathematics education. Findings indicated that pre-service teachers found MEAs ambiguous and difficult to use in teaching mathematics at early grade levels. They; however, also expressed beliefs on MEAs' positive effects on mathematical learning.

Prior research conducted with pre-service teachers mostly focused on their perspectives on MEAs and their performances at designing and solving MEAs. The current study aims to examine not only pre-service teachers' views on MEAs but also their views about the nature of mathematics and of doing mathematics via MEAs.

2. Method

2.1. Participants

The participants, who had no experience on MEAs and no knowledge about MEA perspectives before the course, were enrolled in a mathematics teacher education program in one of the large universities in Ankara, Turkey. They were in the second year of their undergraduate program. At the beginning of the course, 10 heterogeneous groups of three pre-service mathematics teachers were formed according to their GPA. For the current study, nine pre-service elementary mathematics teachers who were members of three study group were interviewed. These groups were selected according to their modeling performances (high, medium, and low) demonstrated throughout the course.

2.2. Content of the Study

The study was conducted during fall semester of 2011-2012 academic years with 30 pre-service mathematics teachers who had been enrolled Modeling in Teaching Mathematics course. The course was offered by the two

researchers for 14 weeks, two hours per week. The course was focused on the theory and practical applications of MEA perspectives via discussions based on MEA literature for 4 weeks and pre-service teachers' engaging with four model eliciting activities (big foot, summer job, summer reading, and quilt problem). As a requirement of the course, pre-service teachers developed one MEA in a 14 week period.

2.3. Data Sources and Analysis

In this study, qualitative data collection methods were used in order to investigate the views of pre-service elementary mathematics teachers on model eliciting activities. A semi-structured focus group interview was conducted with nine pre-service elementary mathematics teachers. The interview took about an hour and it was video-recorded. During the interview, pre-service teachers were asked to talk about their opinions related to the course, how they worked on mathematics as they engaged with MEAs, and whether and how their views on the nature of mathematics and of doing mathematics were changed as they engaged with MEAs. Field notes taken by the researchers during or after the classes and the transcription of the interview were constituted as major data sources. The data were analyzed and coded based on teachers' views about the nature of mathematics and of doing mathematics through model eliciting activities. The themes revealed from the analysis include motivation related to MEAs, nature of mathematics (relationship between math & real life), and nature of doing mathematics through MEAs (group discussions, communication, etc.).

3. Results

The purpose of this study was to identify pre-service elementary mathematics teachers' views on model eliciting activities, as well as to examine their views about the nature of mathematics and of doing mathematics via model eliciting activities. The results revealed that pre-service teachers' views on model eliciting activities are mostly positive. During the interview, pre-service teachers expressed that the course was the most interesting course among the other courses that they had enrolled for the teacher education program. It can be inferred that modeling in teaching mathematics course motivated pre-service teachers to be interested in their profession. They also pointed out that the course is different from the other courses in that they mostly engaged in mental activities throughout the course instead of merely listening to the instructor. This result is consistent with the findings of Türker, et al. (2010) who also stated that pre-service teachers expressed that the model eliciting activities did not look like the problems they had encountered before, and that they required more thinking and logical reasoning. In fact, during the interview participants requested to integrate MEAs into mathematics courses such as Analysis. Türker, et al. (2010) similarly found that pre-service teachers indicated the need for a course that they can develop modeling skills in the teacher education program.

Pre-service teachers' views about the nature of mathematics and doing mathematics through MEAs were also examined in the current study. For this purpose, they were asked to define MEAs and the process they involved in through MEAs during the modeling course. First of all, they defined model-eliciting activities as activities "including real life problem situations they face in their life." Pre-service teachers also mentioned that they realize the actual and significant use of math in real life owing to this course. They stated that their belief about using math in real life was mainly limited to skills related to shopping. Additionally, they pointed out that engaging with mathematics through MEAs is enjoyable and meaningful as these activities require students to make connections between mathematical concepts and real life. It can be inferred that pre-service teachers' views about connections between math and real life are influenced by the experiences during this course.

In the aspect of the nature of mathematics, we can say that pre-service teachers have a traditional view of mathematics before the course. During the interview, one pre-service teacher stated her previous math experience as:

> "*We are accustomed to find only one correct answer in mathematics. If a person answers a problem correctly, then my answer which is different from his/her answer could not be a correct answer. Because there is only one correct answer in mathematics"*

However, she said that after engaging with MEAs they could see how an answer of a complex, real-life problem could be changed when considering different variables given in the problem situations. Particularly, pre-service teachers emphasized that these activities (MEAs) could create opportunities for students to approach problems by taking into account different perspectives. They, however, admitted that they had difficulties to adopt different approaches when they were required to quantify and categorize the relationships among mathematical ideas. For instance, in Bigfoot Problem, pre-service teachers were asked to identify the owner of the mystery footprint and to generalize the method to find the height of a person given the size of his or her footprint (Lesh and Harel, 2003). Pre-service teachers said that they don't take into account the width of the footprint while measuring the size of the footprint although a ruler is provided for them to use. Their traditional views of mathematics may constrain their approaches to the problem.

In parallel to the findings of Eraslan's (2011) and Yu and Chang's (2009) studies, this study also found that pre-service teachers reported that working in groups to solve model eliciting activities was a good way for them to see alternative strategies for approaching and solving the problems. They also stated that group work provided a basis for them to develop confidence for their own thinking. With this respect to this finding, one of the pre-service teachers said,

> *"....Since mathematics problems normally can be done correctly in only one way; students usually can not ask any question to his/her teacher. Since there is not one correct answer in model eliciting activities, I still try to find out the solution of the problem. My other friends in my group also find out different things by looking from a different perspective for the same problem. Then we need to talk with each other. It makes me feel more relax, because there is not only one correct answer."*

4. Conclusion and Recommendation

To sum up, pre-service teachers expressed that MEAs provided them opportunities to see the significant connections between math and real life and allowed them adopting different approaches in solving complex problems. Although pre-service teachers displayed positive improvements about the nature of mathematics and of doing mathematics after taking the modeling course, they also stated the limitations related to using MEAs in their future mathematics classrooms. They identified challenges to use model eliciting activities with particularly in our educational system. They pointed out that they could use MEAs in their mathematics classroom to teach basic math concepts. This finding showed that although pre-service teachers realized the importance of modeling and believed in its necessity, they continued holding traditional views about the nature of mathematics and doing mathematics that they brought to the course. These findings could be expected since pre-service teachers in our study were in the second year of their undergraduate program and they had not yet enrolled pedagogy courses that could provide them opportunities to develop alternative/current approaches to learning and teaching mathematics.

It takes time for pre-service teachers to internalize modeling perspectives. As Eraslan (2011) stated in his study, to create confidence for pre-service teachers to use MEAs in their future classroom, they should gain more experiences.

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