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Procedia - Social and Behavioral Sciences 55 (2012) 1207 – 1214

Procedia
Social and Behavioral Sciences

INTERNATIONAL CONFERENCE ON NEW HORIZONS IN EDUCATION
INTE2012

Student Opinions On Teaching Based On Mathematical Modelling*

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Abstract

This study aimed at determining student opinions about teaching based on mathematical modelling were taken. Study was designed according to descriptive research model. Prospective mathematics teachers carried out the teaching based on mathematical modelling which was included in teacher practices class in elementary mathematics undergraduate program. Before the practice, prospective teachers had a 3 months length education process about learning-teaching applications based on modelling. They prepared classroom practices which include modelling tasks in order to ensure the acquisitions that are included in 6^{th}, 7^{th} and 8^{th} grade mathematics curriculum based on mathematical modelling. During modelling process, the class was divided into groups made of 4-5 people and a homogenous distribution between groups was ensured. 14 voluntary students were chosen from these groups and semi-structured, modelling based interviews were made with them. Data analyzed with descriptive analysis method. When student views were analyzed, it was determined that most of the students have positive thoughts about the teaching. Students stated that they experienced a different class environment, and the study made a positive effect on them in terms of effective learning of mathematics. While some students expressed that the study was enjoyable and applicable, some others stated some negative ideas because of the test anxiety.

Keywords: Teacher education; mathematics education; mathematical modelling**;** prospective mathematics teacher.

1. Introduction

Mathematics is a systematical way of thinking that creates solutions to real world events with modelling. Modelling can be defined as converting an existing problem to mathematical notations and representations (Burkhardt & Pollak, 2006; Niss, 1987; Kaiser; Blomhój & Sriraman,2006). Mathematical modelling is meant to help students' better understand the world, support mathematics learning

* This study is prepared from a part of PhD Thesis named "Learning-Teaching Applications on Mathematical Modelling in Mathematics Education".

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 doi:10.1016/j.sbspro.2012.09.616

(motivation, concept formation, comprehension, retaining), contribute to develop various mathematical competencies and proper attitudes, contribute to create an adequate picture of mathematics, namely using enough mathematics. In this context, purposes of mathematical modelling are; enable students make predictions, explain problems, describe and understand different situations in the real world (Galbraith & Catworthy, 1990).

Mathematical modelling is an important component of professional training, which is similar in all areas, particularly in mathematics education. The incorporation of mathematical modelling in mathematics education provides a learning environment (D'Ambrosio, 2009). There are many characterizations or modelling cycles of modelling process (Hirstein, 1995; Berry&Houston,1995; Borromeo, Ferri, 2006; Galbraith & Stillman, 2006; Verschaffel, Greer & De Corte, 2000). A cognitive analysis of modelling process gives a model of the modelling cycle. Modelling cycle can look like algorithmic process, but indeed it is not. Especially the construction process of modelling is challenging as it include formulating a problematic situation. The process requires selection of appropriate variables, determining connections between these variables, developing a mathematical model related to these variables and connections, and testing the model and its applications. The basic purpose of involving mathematical modelling in secondary school curriculums is to encourage students make connections between mathematics and the real world (Blum & Niss, 1991).

One of the process models to describe modelling activities is the modelling cycle proposed by Blum & Leiss (2007). In an idealised form, the solution process for a modelling problem can be characterized by a seven-step sequence of activities: (1) understanding the problem and constructing an individual "situation model"; (2) simplifying and structuring the situation model and thus constructing a "real model"; (3) mathematising, i.e. translating the real model into a mathematical model; (4) applying mathematical procedures in order to derive a result; (5) interpreting this mathematical result with regard to reality and thus attaining a real result; (6) validating this result with reference to the original situation; if the result is unsatisfactory, the process may start again with step 2; (7) exposing the whole solution process. From this point of view, the modelling process is made up of seven steps. Distinguishing between these steps is helpful for reconstructing the modelling processes used by students when solving mathematical problems. However, students' actual processes are typically not linear but rather jump back and forth several times between mathematics and reality (Borromeo Ferri, 2007; Leiss, 2007).

According to the mathematics educators, students have opportunities to use and apply mathematics through mathematical modelling (Blum & Niss, 1991). Mathematics classes that are designed in the form of using mathematical modelling, give students chance to use mathematics actively. Students with mathematical modelling competencies learn and develop mathematical concepts very well which makes important contribution to their mathematical experiences outside school (Aydın, 2008).

If this phenomenon can be learnt as early as secondary school, high school will be able to evaluate everything mathematically in their lives and will be more successful in mathematics classes. PISA 2006 results revealed that students all over the world have some problems with modelling tasks (EARGED, 2010). At the end of PISA professional mathematicians' analyses, difficulty of modelling tasks were able to be explained by the cognitive complexity.

In this context, in order to improve present conditions, it is very important to increase the education activities based on mathematical modelling and their effective practices in classes. In this study, which aims at determining students' views in present situation, students' ideas on the issue of mathematical modelling were taken.

2. Method

The study was designed according to the qualitative research and was carried out on the second semester of 2010-2011 academic years. Prospective mathematics teachers carried out the teaching based on mathematical modelling which was included in teaching practices class in elementary mathematics undergraduate program in Balıkesir University. Before the practice, prospective teachers had a 3 months length education process about learning-teaching applications based on modelling. In this process, they prepared lesson plans which include modelling tasks appropriate for the acquisitions that were included in the 6^{th}, 7^{th} and 8^{th} grade mathematics curriculum; these modelling tasks were evaluated by researchers and took their last shape. Prospective teachers implemented teaching applications according to their lesson plans. Before the teaching applications, students were divided into groups made of 4-5 people. Mathematics class teacher's and students' opinions were taken in deciding the group members and a homogenous distribution was ensured. 14 voluntary students were chosen from these groups and semi-structured, modelling based interviews were made with them. Data were gathered with an interview form prepared by researchers and analyzed with descriptive analysis method (Yıldırım & Şimşek, 2005).

3. Findings

When student views were analyzed 7 sub-themes were seen. These sub-themes are: contributions of group studies, contributions of class discussions, views on modelling tasks, views on teachers' role, and contributions to learning mathematics, anxiety and enjoyment. Descriptive findings of the data are given in Table1.

Table 1. Descriptive findings of the data .

Main Theme	Sub Themes	Codes	Quotations from Student Views
Views on Mathematical Modelling based teaching	Contributions of Group Studies	• The effort to prove oneself • Attendance of general class • Collaboration • Active participation • Creating common ideas • Homogenous distribution of groups	S1. It wouldn't be this much beneficial if we'd study together. In this method, everybody said something to prove himself/herself. S12. I was satisfied with the group study. There were some conflicts sometimes, but these were the joy of the study. S2. Groups were proportional, equal in terms of information. If we would arrange the group, it wouldn't be better. The others would look while one or two were studying. All of the class participated in the study in this way. S8. We saw that our ideas agreed. We gave decisions in here as a group, it was easier. S13. As there were group studies in that, we had the chance to work together more. S14. There are some successful and unsuccessful students in our class. If we would determine group members, we would be better than the other groups. Teachers' gave more fair decisions; almost all of the groups were equal. If we'd work individually, everyone would find something different; we wouldn't come to an agreement. We worked together, collaborated; so all ideas were gathered in one place, it was better. S1. There were no groups in mathematics classes, this is better. We can ask our friends if we can not do something. It wouldn't be this much effective if we did this individually.
	Contributions of class discussions	• Defending group's solution • Seeing different solutions • Realizing mistakes	S6. It was better for groups that made mistakes. They realized that they made mistakes on the paper, and corrected their mistakes on the board. They won't forget what they learnt. S11. When we solved questions on the board as separate groups, we saw one another's mistakes. For example I was sure that we found the right solution; when I saw that we gave

	• Desire to win • Competition	wrong decision I was shocked. S13. Discussion environment was useful for us as we were able to see our mistakes. S10. Class discussions were very well, we saw our friends as competitors. We tried to beat them and became ambitious. This enabled us become more effective in defending our solutions. Namely, discussions were good. S14. As we discussed solutions in class, we had the chance to see our mistakes. We became more ambitious as there were groups. S4. We agreed on the solutions we made in groups. Although there were debates in class discussions, we saw our mistake, which was better. Some of us saw his/her mistakes before it was too late. S2. I think class discussion was very effective. Because I was absolutely sure that our answer was correct. We checked it a few times. But something changed when we came to the board. We thought that their answer was more sensible. I was shocked when I saw that we did wrong.
Views on modelling tasks	• Interesting • Increasing curiosity • Not easy • Not difficult • Thought provoking • Necessary • From daily life • Appreciation • Valuable • Entertaining	S3. Making calculations were interesting. We were curious about the solution while dealing with the problem. S4. Problems weren't difficult, but they weren't easy either. S5. Applications were enjoyable, and more thought provoking. S14. Activity wasn't that much easy, there were especially a lot of operations. S1. Questions in the activity weren't easy or difficult. They were all necessary. S5. Everybody liked the activities; they were reflecting the parts of our lives S6. It was very valuable for us, it made us feel valuable, we were being thought. That was why we liked them.
Views on teacher's role	• Guidance • Supporter • Encouraging to thinking • Questioning	S7. Teacher in this class was better. He/She was more interested. He/she gave very clear answers to our questions in a way that we can understand. S10. He was sympathetic. If we would make individual studies, he couldn't answer all of our questions. He gave answers to most of the questions. S1. I was anxious at the beginning, I didn't know if I could answer; it was easier when the teacher came and explained. S2. The teacher was like a supporter, he/she was our second way. He/she was like a guide and eased our studies. S4. The teacher wanted us to decide which method to use. He/she only asked questions like "how would it be if you used this way?" and made some suggestions. S1. Teacher guided and encouraged us to think, said that I didn't give this in this question, find it on your own.
Contributions to mathematics learning	• Arousing interest • Focusing on the task • Seeing different activities • Realizing mistakes. • Seeing friends' situation. • Permanent learning • Effective learning • Learning from one another • Learning and	S12. As everybody focused on the class, they did something. Everybody was interested. Some people wouldn't be interested if we studies individually. S10. Generally everybody liked the activity; these kinds of studies are very attractive. Everybody focused on that at the same time. I am picturing the situation now, everybody is thinking about the same thing, which one is the right answer, who is right who is wrong… S13. We become more ambitious if we are taught in this way, our interest in mathematics increase. S10. If mathematics is taught by this way, I think everybody would become more interested, it would be enjoyable.

	enjoying • Endearing mathematics • Looking from a different perspective	S1. We always thought about formulas. We don't do such activities in mathematics. S5. Everybody in group study firstly wrote their opinions on papers, and then we combined them in a paper. For instance I found a solution but it was false. I realized my mistakes. S11. In our group studies, we saw that some of our friends were better than us –we are successful in mathematics-. I didn't realize that before as they hadn't told us. We are in the class for years; I had never seen that before. It was very well for this. S7. I liked the application very much. We reached a cone in a way with stars and we rearranged the formula we know according to the data. We arranged them in order to reach solution. This was a very good example for us to see that only memorizing the formula isn't enough. S6. When the activity is individually made, different answers are given. We weren't able to see our own and our friends mistakes clearly in that way. S9. Our learning was more permanent with this method. If we do such applications in order to repeat an issue, it becomes permanent and we don't forget. S10. We both enjoyed the process and learnt. It was very good. S4. We learnt a lot from one another both in groups and on the board. S11. Mathematics learning becomes more permanent, solutions become well if we take classes in this way. S7. I think that these practices are more effective in our learning. S5. I gained something in this lesson. For example with the help of group study, I saw where and why I made mistakes. I saw from a different perspective which method should we use. It was a good activity for me. S4. If I see a similar question in secondary education entrance exam, I will be able to answer consciously. We didn't know what and how to do; this is why this application was very useful for us.
Anxiety	• Irritated • Stressed • Being afraid of getting reaction • Being relaxed	S13. When we heard that there will be groups, we first thought that there were going to be a competition. I became agitated as I didn't know if I could be successful. S1. I was a little stressed as we were being recorded on video. S9. We relaxed as we spent more time with teacher. S8. The students who weren't convinced with the class discussions said "what we did is right", I think that they didn't want to draw reaction from their group friends.
Enjoyment	• Enjoyable • Nice • Good • Pleasure	S11. In my opinion, the lesson was enjoyable. We also solve problems in the class but they aren't as difficult as this. We also don't study with groups, we study on our own. This is why these applications were better. S1. Generally everybody said that they enjoyed and took pleasure from mathematics lesson. S10. Activities were good; enjoyable and nice; generally everybody said that they enjoyed. S5. The lesson was good, I enjoyed it very much. S6. I got happy because we had never done these kinds of stuff in my previous school. It is easier for us to learn something while enjoying. This is why this method is better.

We see the views on mathematical modelling based teaching as the main theme in Table 1. As modelling process continued in this teaching, views on modelling process can be taken as the main theme. Kyleve & Williams (1995) identified that students' abilities have some effects on their attitudes. According to this finding, it can be said that students' modelling abilities affect their attitudes. Because sub-themes that were determined according to the data put forward the experiences and feelings in the process. Lim, Tso & Lin (2009), analyzed the attitudes of students towards mathematics in 4 dimensions: beliefs, usefulness, enjoyment and anxiety. Beliefs are the judgments that students make for the application and they are based on knowledge and previous experiences of students. Usefulness is defined by the researchers to be what is useful for and in favor of students, practical and what makes the project worth being applied. While enjoyment is defined to be satisfaction and not feeling any pressure, anxiety is feeling pressure and anxiety about the project.

When these definitions are analyzed, it is seen that the sub-theme of "contributions to mathematic learning" that we determined in our study (*focusing on the class, arousing interest, seeing different solutions, seeing friends' situation, realizing mistakes, permanent learning, learning from one another, learning and enjoying, endearing mathematics, effective learning)* includes beliefs and usefulness. Lester Jr (1987) stated that beliefs are made of the subjective knowledge developed by a students in order to interpret events. Galbraith et al(2003), mentioned that beliefs in mathematical modelling which affect judgments and views are very important in terms of putting model's variables forward. In this context, students emphasized that modelling process is a useful device in learning mathematics and they will see the possible advantages in their future career.

Most of the students stated that the education was enjoyable and good, they enjoyed the process and they were satisfied. These views are grouped under the theme of enjoyment. Galbraith, Izard & Christopher (2003) stated that enjoyment is an instinctive or intuitive feeling that students show in their mathematical experiences. In this context, another important side of the study was revealed with the fact that students had positive feelings about teaching, and they said that they both enjoyed the process and learnt at the same time, they had the chance to study more effectively in a more comfortable environment.

Study group who were preparing for secondary education entrance exam participated in this study. There are fewer questions in modelling tasks. Very few of the students stated this feature to be a negative feature of teaching based on mathematical modelling.This was expected as students had test anxiety; students attended the application stated that their knowledge will be useful in future, they were enjoying the process while learning and they didn't have learning anxiety while studying on modelling tasks.

Kaino & Salani (2004) determined similarly in their studies that students related the usefulness of their study with their future professional lives; but on the contrary to our study, as the negative side of teaching, they expressed that they didn't enjoy the process and they related this with learning anxiety instead of test anxiety.

4. Conclusions

When students' views on mathematical modelling were analyzed, it was determined that most of the students in this study had positive views on the mathematical modelling based teaching. Students experienced a different application in mathematics class and the study positively contributed to them in terms of learning mathematics. Increasing students' mathematical success on international level, ensuring effective and permanent learning of mathematics can be done and students' anxieties can be relieved with education situations that are prepared according to mathematical modelling.

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