REVEALING PRIMARY SCHOOL CHILDREN'S MATHEMATICAL MODELING POTENTIAL: HAIRDRESSER SALON PROBLEM

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Abstract

To be able to cope with complex systems, it is important for mathematics education that children have experience with situations in which they gradually engage the real problem with complex systems and interdisciplinary complex systems at starting from the primary school. In doing this, mathematical modeling consisting of cycles of model eliciting and relating model with real-life is one of the available approaches. Therefore, the purpose of this study was to reveal the models of fourth-grade primary-school children, who have no prior experience with modeling problems in their classroom. This research study was conducted during the 2016-2017 academic year, in a university-foundation primary school in a large city along the Black Sea Region of Turkey. Participants were a total of 20 children in one of the 4th grades. The children in groups of four were assigned a modeling activity, the *Hairdresser Salon Problem*, to work on for two class-hours as a group. Modeling processes of each group and presentations at the end were video and audio-taped. The mathematical thoughts, developed models, written responses of the primary-school children were qualitatively analyzed in the light of the modeling cycle developed by Blum and Ferri [1]. The results showed that children were able to concert symbolic data into numerical data, take into account of different parameters (hair cutting and washing cost, waiting time, distance from home, hair washing time, hair cutting time, hair styling time and customer satisfaction) together and make mathematical calculations in the modeling process. At the end, they presented and explained their models if they were appropriate.

Keywords: primary school children, mathematical modeling, hairdresser salon problem.

1 INTRODUCTION

In recent years, children are confronted with a World, in which there is complex, dynamic and powerful information systems around them in the line with knowledge-based environment. In order to interpret complex systems and use them, individuals must have the ability to analyze, coordinate and organize together with mathematical skills such as creating concepts, using different representations, delivering results, guessing, descripting, validating and working with groups. At this point, one of the most important tools to achieve this goal in mathematics education is mathematical modeling activities. International literature has shown that with the help of Model Eliciting Activities (MEAs), students have developed high-level thinking skills [4], completed deficiencies in conceptual understanding [5], helped them discover the relationships among parameters in the problem [7], and developed the ability to read and interpret data on tables [6]. On the other hand, an investigation into the national literature in the field shows that there are only the studies conducted by Sahin [2], Sahin & Eraslan [3] which aimed at identifying primary school students' mathematical modeling skills in Turkey. Therefore, the purpose of this study is to investigate the models and the modeling processes of fourth-grade primary school students and to identify challenges that may arise in the process.

1.1 Theoretical Framework

In the present study, Blum and Ferri's [1] modeling cycle was used (Fig. 1). They explain the four phases of the modeling cycle as follows: At the understanding the task phase, in order to understand a problem that has been taken out of the context of daily life, the student performs tasks such as reading, imagining, drawing and reading tables that have been designed to bring simplification to the problem at hand. In establishing models, students create the data needed, find and recognize the relationship and rules, become aware of the patterns and form a hypothesis. In the using mathematics step, the students are expected to determine the appropriate mathematical concepts, perform the suitable mathematical operations and thus reach a mathematical solution at the end of these operations. The cycle ends with the students' checking the accuracy of what they have done, verifying the validity of the model by comparing the result with real life and reporting the solution, all of which make up the explaining the results phase, the last in the cycle.

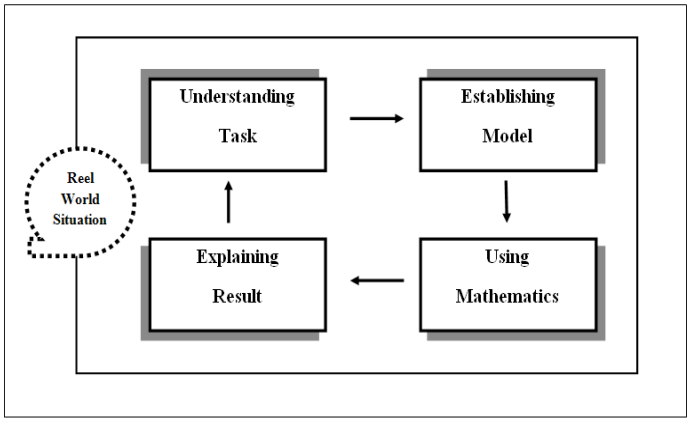

Figure 1. Blum and Ferri's modeling cycle.

2 METHODOLOGY

As part of a larger body of research designed to identify primary school students' mathematical modeling competencies, MEAs were assigned to children in groups of four at a university-foundation primary school in a large city along the Black Sea Region of Turkey. Participants were a total of 20 children in one of the 4th grades. The children in groups of four were assigned a modeling activity, the *Hairdresser Salon Problem*, to work on for two class-hours (80 min.) as a group. Modeling processes of each group and presentations at the end were video and audio-taped. The mathematical thoughts, developed models, written responses of the primary-school children were qualitatively analyzed in the light of the modeling cycle developed by Blum and Ferri [1]. The researcher took an active role as a practitioner-teacher in the process while the classroom teacher was observer in the whole process.

Hairdresser Salon Problem consists of a table of data belonging to five different hair salons in that area. Additionally, six other columns in the table show some important information about cutting and washing price, waiting time, distance from home, washing time, cutting time, styling time and customer happiness for each hair salon. The groups are asked to use the data in the table to develop a method which can help them decide which one the best hair salon that suits their teacher in that area and then write a letter explaining how they found this method. Hairdresser Salon Problem is a Model-Eliciting Activity. MEAs are open-ended, interdisciplinary problem-solving activities that are meant to reveal students' thinking about the concepts embedded in realistic activities. There are no single correct answers when solving a model eliciting activity. Instead, there are many possible solutions and procedures because solutions are meant to be generalizable. Students are encouraged to use a specific type of thinking and process the information given, as well create a logical answer to the problem that they are then able to explain.

3 RESULTS

3.1 Understanding the Task

In the first step of the modeling process, *understanding the task*, all groups firstly read the problem with a loud voice and then underlined the important words in the problem-text and discussed how the best hairdresser should be.

3.2 Establishing Model

In this step, firstly all the groups converted the symbolic data, which is customer satisfaction, into numerical data. In the second phase; one of the five groups was unsystematically coded using the (+) and (-) symbols of each hairdresser and went on to sort by total number (+) on all data. The other four groups gathered the waiting time at the hairdresser, hair washing time, haircutting time and hair shaping times and simplified the problem by reducing the four parameters into one and found new data by finding the total time in hairdresser. Later, they went to sort by comparing customer satisfaction, hair washing and cutting costs, the distance from the home, and the total time in hairdresser. In the following stage, firstly all the groups decided that Salon Seda and Tuna Hair Design

Center could not be the best hairdresser because these two hairdressers were far away from home, long total-hairdresser-time and low customer-satisfaction. Then they placed Salon Seda and Tuna Hair Design Center their latest 4 or 5 in the lists. On the other side, three of the groups selected Radikal hairdresser as the best hairdresser among the rest of the hairdressers (Ata, Radikal and Holywood hairdresser) while the other two groups selected the Hollywood hairdresser. In both Radikal and Holywood hairdressers, since hair washing and cutting costs (30 TL) and customer satisfaction (24/30) were the same, the groups made their decisions based on the total-hairdresser-time and the hairdresser-home distance. At this point, relating the problem to real life, while some groups selected Holywood to act on the assumption that time (Holywood hairdresser: 53 min.; Radical hairdresser: 69 min.) is more important in the busy life, some others selected Radikal hairdresser based on the assumption that the distance (Radikal hairdresser: less than 1700 m.; Holywood hairdresser: more than 1700 m.) was more important than the others. In this way, all groups completed the process by sorting the five hairdressers given to them in the form of a table.

3.3 Using Mathematics

At the step of the use of mathematics, three of the five groups turned the symbolic signs of customer satisfaction correctly into numerical data and were ordered by calculating the total time spent at the hairdresser. While one of the remaining two groups correctly translated customer satisfaction, the total time spent in that room for each hairdresser was miscalculated. The other group incorrectly made calculations both the customer satisfaction and the total time in the hairdresser.

3.4 Explaining the Result

In this step, the groups explained and reported on what factors they considered to find the best hairdresser and how they evaluated it. When questioned about the correctness of their results, the groups stated that they had checked the process twice and they thought from every angle.

4 CONCLUSIONS

This study was carried out with a total of 20 fourth-grade primary school children students who worked on the Hairdresser Problem. During the problem-solving process, at each stage, the groups tried out hypotheses that they associated with everyday life, produced ideas, made calculations, and explained the accuracy of their models by making associations with real life. In the first step of the modeling process, understanding the task, the groups showed no difficulty to understand the problem. In the establishing model step, they converted the symbolic data into numerical data, developed systematic and unsystematic models and took into account of different parameters together to interpret the data such as hair cutting and washing cost, waiting time, distance from home, hair washing time, hair cutting time, hair styling time and customer satisfaction. On the other hand, in the using mathematics step, the groups made some miscalculations by performing simple mathematical operations such as addition, multiplication, and putting into order on the basis of quantity. As to the results explaining step, the students successfully reported in the letter they wrote the factors they considered in developing their model and how they assessed these factors.

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