



Mathematical Modeling in Primary School: Students' Opinions and Suggestions on Modeling Activities Applied as a Teaching Experiment

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One of the main purposes of teaching mathematics is to enable students to solve real-life problems and relate mathematics to real-life situations. As a way of facilitating the teaching of mathematics, it should be applied in lessons with mathematical modeling activities of real life problems. The aim of this study is to determine the views of primary school 4th grade students who have experienced mathematical modeling activities for 9 weeks and their suggestions for future modeling activities. The participants of the study are 12 students selected by purposive sampling method among 69 students attending the 4th grade of a public school in Konya in the 2019/2020 academic year. As a result of the study, students; In addition to positive opinions such as increasing the interest of mathematical modeling activities in the lesson, increasing their success in mathematics lessons and improving their social skills, they also expressed negative opinions such as long questions, problems in group work and insufficient time.

Keywords: Mathematical Modelling, Model Building Activities, Primary School, Student Opinions, Teaching experiment

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Introduction

In recent years, developments in the field of education have brought about changes in education programs. The primary school mathematics curriculum was also affected by the updated education programs. Especially with the changes made in 2005 and after, there are significant differences in the mentioned program. One of these changes is the expression of mathematical modeling in the 2009 primary school mathematics curriculum (MEB, 2009). This change is seen in the 2015 and 2018 programs as the contribution of mathematical modeling applications to teaching in the "issues to be considered in the implementation of the programs" (MEB, 2015 and 2018).

One of the most important applications of science, technology, engineering, mathematics and design, which are the components of STEM+A applications, which is the last reflection of science and technology in education, is undoubtedly mathematics. It is thought that the use of mathematics in daily life and the transfer of mathematics to students in a concrete way will increase the success of the students in this course. One of the general aims of the mathematics course is to develop students' problem solving skills. It is seen that the problems frequently used in mathematics lessons are not sufficient for students to associate mathematics with real life situations (Erbaş et al., 2016). This inadequacy can be overcome with problems involving daily life situations, and students can develop positive attitudes towards mathematics. Particularly in the primary school period, teaching methods that support students to develop positive attitudes towards being able to succeed in should be employed. In this way, students will be able to achieve mathematics and will enjoy this lesson by developing a positive attitude towards mathematics. Students who develop positive attitudes towards mathematics will also be able to use mathematics in their daily lives. The results obtained in PISA (2015 and 2018) and TIMSS (2015 and 2019) exams reveal that 4th and 8th grade students in our country have difficulty in making open-ended questions that relate mathematics to daily life. This difficulty can be overcome by using mathematical modeling activities in the lessons.

The national council of mathematics teachers evaluated mathematics education within the framework of principles, standards and processes in its report (NCTM, 2000). When we examine the 2018 mathematics curriculum, it is seen that the learning areas have a similar scope to the content section in the report published by NCTM, and that it coins with the principles and process standards in the NCTM report in the "Turkey Qualifications Framework" (TYÇ), which is the main basis for the implementation of the program. Mathematical competence is

the development and application of mathematical thinking to solve a range of problems encountered in daily life. It is important that students gain mathematical competence, especially in the primary school period. We need to convey mathematics, which is found in all areas of our lives, to students, especially in the primary school period, by concretizing and making the verbal problems to be solved meaningful. The biggest difficulty encountered in mathematics education when students work with daily life problems is that students cannot transfer the knowledge they learned during the problem-solving phase to daily life (Altun, 2018, p.125). In cases where we cannot achieve this transfer, even if the students solve the problem correctly by using their procedural knowledge from the given information, they cannot associate this solution with daily life.

Associating mathematics with daily life and making the solution of verbal problems addressed to students meaningful by associating them with daily life is important for the permanence of learning. In this context, the most important factor that determines the adequacy of student success in solving problems in daily life is the competence of students in applying their mathematical knowledge to daily life situations (Greer, 1993). In order to relate mathematics to daily life and to solve daily life problems, students should be able to transfer knowledge from mathematics to daily life, develop and use original strategies and models, make logical predictions about the solution, and evaluate the accuracy of the result in the context of daily life (Chacko, 2004, p. 96).

One of the applications that relate mathematics to daily life situations is mathematical modeling activities. (Lesh & Doerr, 2003; English & Watters, 2005). Explaining the concepts of model and modeling before explaining mathematical modeling will help to understand this concept. Models are schemas defined by abstraction or generalization that occur in the mind during the problem solving process (Kertil, 2008). In other words, the model is the whole of the products formed in the mind during the problem solving phase. Considering the definitions of model and modeling, model and modeling in mathematics is defined as making complex systems mathematically meaningful through mathematical expressions (Lesh & Doerr, 2003). The model is the whole of the conceptual structures existing in the mind and the external representations of these structures in order to interpret and understand complex systems and structures (Doruk, 2010). As can be understood from the definitions made, the model; It is a product that will help solve the problem by going through different mental processes in the problem solving process of a situation we will encounter in real life. While we describe the model as the product that has emerged, we can evaluate the modeling as the process that occurs

in the emergence of this product. In general terms, mathematical modeling is defined as a process that includes the analysis of a real-life problem with mathematical methods by transferring it to the world of mathematics (Borromeo Ferri, 2006; Bukova Güzel, 2016; Maaß, 2006). Many researchers define mathematical modeling as a process that involves the analysis of a real-life problem by transferring it to the world of mathematics and using mathematical methods (Borromeo-Ferri, 2006; Bukova Guzel 2016; Maaß, 2006). There are two prominent elements in the definitions of mathematical modeling. The first is the consideration of mathematical modeling as a process, and the second is the relationship between the real world and the mathematical world. Mathematical modeling refers to problem solving processes associated with real life, which can be interpreted differently by each student, as opposed to open-ended, routine word problems that do not contain a single correct answer. According to Maaß (2006), in modeling activities, students need to make sense of the real-life situation and express it in mathematical language, analyze and interpret the information given about the situation, select the necessary data and associate the solution with the real-life situation within the framework of these data. He also states that modeling activities are more effective than traditional word problems for the discovery of mathematics in real life and the mathematical development of students (Maaß, 2006). According to Bukova Guzel (2016), in the solution process of mathematical modeling activities, the real life situation is expressed by mathematizing, the problem and the factors affecting the solution of the problem are specified, and the answers regarding the solution of the problem are tried to be reached based on assumptions. Lesh and Doerr (2003) define mathematical modeling as a process, which they see as a phase of Model Eliciting Activities (MEAs). In this context, MEAs are non-routine problems in which students are asked to produce solutions that can be based on more than one assumption in order to generalize the model they have created, and where different possible solutions are re-evaluated, by working in groups, students propose different solutions to real-life problems.

As a result of the radical changes made in primary school mathematics curriculum after 2005 in Turkey, a problem-solving-oriented approach is adopted and students are expected to reflect their problem-solving situations in real life. It will be possible for students to have the problem solving skills expected from them and to transfer them effectively to daily life situations with the classroom environment to be created and the textbooks prepared in this direction. However, it is seen that classrooms cannot be fully transformed into an environment where these skills can be gained (Uğurel, et al., 2011). In addition, it is thought that how students perceive

mathematical modeling activities, what they experience during the application and their views on these activities are important in creating a problem-solving-based classroom environment. It is possible to talk about different components of these classroom environments. Running non-routine mathematical problems associated with real-life situations is one of the important elements of these components. One of the teaching methods applied in this context is the mathematical modeling activities that have become widespread in Turkey for the last 20 years. There are many studies on the planning, implementation and evaluation of mathematical modeling activities (Doruk, 2010; English & Watters, Eraslan, 2011; 2005; İncikabı, 2020; Kaiser & Brand, 2015; Kertil, 2008; Tekin Dede, 2015; Tekin, et al., 2011; Thomas & Hart, 2010 and Şahin, 2019). However, it has been determined that the number of studies evaluating students' opinions about mathematical modeling experiences is limited in number, and there is no study in which primary school students' views on mathematical modeling are taken. It is thought that this study will contribute to the field with this aspect.

When the national literature was examined, it was seen that the studies evaluating the reflections of mathematical modeling and modeling activities were carried out with teachers, prospective teachers, undergraduate and secondary education students. (Bilen & Çiltaş 2015; Deniz & Akgün, 2014; Deniz & Akgün, 2016; Eraslan, 2011; Güder, 2013; Işık & Mercan 2015; Karalı, 2013; Pilten, et al., 2016; Şahin & Eraslan, 2019; Tekin Dede & Bukova Güzel, 2013; Tekin, et al., 2014; Tutak & Güder, 2014; Urhan & Dost, 2016). In these studies, researchers used mathematical modeling; They concluded that they developed a positive attitude towards mathematics, contributed positively to mathematics learning, and that it would be beneficial to perform them together with project-performance tasks. In addition, in the studies where teachers' opinions were, they stated that the situations such as that the teachers did not take sufficient equipment for the application of mathematical modeling, that the students in the classroom were not accustomed to modeling activities and that the application environments were not suitable caused difficulties.

Özdemir and Üzel (2012) took the opinions of 14 students attending the 6th, 7th and 8th grades in learning environments based on mathematical modeling. As a result of the three-month training, most of the students expressed a positive opinion about the teaching process. While some students stated that the study was enjoyable, others expressed their negative thoughts due to exam anxiety. In addition, the students stated that they experienced a different classroom environment and that the study was positive in terms of effective learning of mathematics. Eraslan (2011) in his study, in which primary school mathematics teacher

candidates' views on model building activities and their effects on mathematics learning were examined, stated that pre-service teachers' mathematical modeling activities have limitations as well as that they can be used at different levels from primary education to higher education and that they can contribute positively to mathematics teaching.

Tekin Dede and Bukova Güzel (2013), on the other hand, took the opinions of 17 teachers in their study in which they examined the model building activity design processes. the opinions of the teachers were evaluated before and after the modeling activities, and as a result of the study, the teachers stated positive opinions about the use of model building activities in the lessons; however, it is difficult to prepare such activities; therefore, they stated that the diversity of activities should be increased. In addition, the teachers who stated that they could use these activities at the beginning or at the end of the subject, within the scope of term papers or projects, stated that they would decide on the frequency of use depending on the suitability of the subject and time. Tekin et al., (2014) stated in the study that 21 primary school pre-service teachers' opinions on model-building activities were obtained, that mathematical concepts were made more concrete, that mathematics was associated with daily life, and real-life situation was better understood with these activities. . Urhan and Dost (2016) took the opinions of nine mathematics teachers about the use of modeling activities in lessons. As a result of the study, besides positive views such as making connections between mathematical subjects of modeling activities, associating mathematics with daily life and increasing motivation towards mathematics; They reported negative opinions such as modeling activities are not suitable for use in mathematics teaching, the education system is not suitable for modeling applications, and teachers are lacking in modeling activities.

When the international literature is examined, Thomas and Hart (2010) took the opinions of 16 primary school teacher candidates about mathematical modeling. Besides the negative thoughts of the pre-service teachers such as the lack of a certain process to be followed as a result of the flexibility of the solution of modeling activities, the difficulty of its implementation and its limitations; They stated that it would be interesting to have more than one correct answer and that students could develop different thinking skills. Kang and Noh (2012) stated that they contributed to the development of high-level thinking skills of students with mathematical modeling activities in the study in which they obtained the views of pre-service teachers through modeling activities. Soon and Cheng (2013), in their study with pre-service teachers, stated that model building activities would contribute positively to students' mathematics learning.

When the relevant literature is examined, it has been determined that the opinions and evaluations of mathematics teachers, graduate students, high school and secondary school students about mathematical modeling are taken, but there is no study about the opinions of primary school students. Within the scope of this study, students were asked to make a preliminary study in order to determine their real-life situations. A classroom environment focused on solving mathematical modeling activities appropriate to the context of the preliminary study was created. In this classroom environment, students' mathematical modeling competencies were determined and their opinions on the implementation of these activities and suggestions for future activities were taken. For this purpose; following research question were formulated:

- 1) What are the students' ways of solving mathematical modeling activities?
- 2) What are the positive and negative situations that students encounter while solving mathematical modeling activities?
- 3) What are the positive and negative opinions of students about mathematical modeling activities?
- 4) What are the students' perspectives towards the mathematics lesson after the mathematical modeling activities?

Method

This study is a qualitative study aiming to reveal the opinions of primary school 4th grade students about the mathematical modeling activities they experienced for nine weeks and the suggestions of the students for the application of mathematical modeling activities. The nine-week teaching activities were designed with a teaching experiment since they can be changed and renewed according to student learning throughout the research, are carried out with consecutive teaching sessions, and the researcher is in the role of a teacher (Steffe, 1991; Steffe & Thompson, 2000). Teaching experiment is a dynamic method designed primarily to explore and understand students' mathematical activities (Steffe & Thompson, 2000). In other words, as a method of teaching experiment, it is aimed to examine the development of students in a certain process and as a result of these examinations; It is the renewal of continuing education departments in a way that will contribute to student learning. The pilot implementation of the activities was carried out in the first term of the 2019-2020 academic year, and the main implementation was carried out in the 2nd term. Three of the modeling activities (“Which

vehicle shall we go to the picnic with?”, “Big Foot” and “Weather” (Appendix 1) (Doerr and English, 2003) of the modeling activities used in the applications were adapted from the relevant literature, and the other six (“Kermes”, “Migratory Birds”), “Who Runs?” (Appendix 2), “Which Battery Vehicle Should We Rent?”, “Uncle Farmer Hüseyin” (Appendix 3) and “How Should We Build the Barge?” were developed by the researcher. The features that mathematical modeling activities should have were used in the preparation of these activities (Lesh et al., 2000; Lesh & Caylor, 2007; English, 2009). During the preparation of the activities, the opinions of the teachers of the classes where the main application and the pilot application will be made were taken. to the examination of two Turkish teachers in terms of linguistic compatibility. The schedule of e and semi-structured interviews is presented in Table 1.

Table1. *Calender of Activities and Semi-Structured Interviews*

<i>Pilot Study</i>	<i>Main Study</i>	<i>Applied Activity</i>	<i>Activity Type</i>
01.10.2019	05.02.2020	Which Vehicle Shall We Go to the Picnic With?	Pre-Clinical Interview
03.10.2019	07.02.2020	Kermes	1. Mathematical modeling group application
10.10.2019	14.02.2020	Migratory Birds	2. Mathematical modeling group application
17.10.2019	21.02.2020	Who Runs?	3. Mathematical modeling group application
22.10.2019	26.02.2020	Which Battery Vehicle Should We Rent?	Intermediate- Clinical Interview
24.10.2019	28.03.2020	Big Foot	4. Mathematical modeling group application
31.10.2019	06.03.2020	Uncle Farmer Hüseyin	5. Mathematical modeling group application
07.11.2019	27.04.2020	How Should We Build the Barge?	6. Mathematical modeling group application
14.11.2019	04.05.2020	Weather	Final Clinical Interview
18/19.11.2019	07/08.05.2020	Semi-Structured Interview	

Research Group

This study was carried out with six students, each selected according to the criterion sampling method, among 33 students attending 4-H class (pilot application class) and 36 students attending 4-K class (main application class) of a public school in Konya. While determining these students, it was sought to get a score of 70 and above from the achievement evaluation form (Appendix 4) developed by the researcher, and to be able to express themselves well and have developed social adaptation skills at the end of the interviews with the classroom teachers. The real names of the students participating in the study were not used, each of them was given different code names. In order not to reveal the identities of the participants, the name of the school they studied was not mentioned in the study. Information about the participants is given in Table 2. below.

Table 2. *Information About the Participants*

<i>Participant</i>	<i>Number of Sibling</i>	<i>Date of birth</i>	<i>of Mother Education Status</i>	<i>Father Education Status</i>	<i>Having a Computer at Home</i>	<i>Availability of Internet at Home</i>	<i>Years in the Same Class</i>
Eren	1	21.10.2009	Master	Master	Available	Available	4
Serra	2	07.01.2010	Master	Master	Available	Available	4
Selin	1	08.02.2010	University	Associate Degree	Available	Available	4
Mert	3	31.01.2010	High school	Associate Degree	Available	Available	4
Kerim	2	04.07.2010	Master	University	Available	Available	4
İpek	1	13.11.2009	University	Master	Available	Available	3
Ali	3	09.04.2010	University	University	Available	Available	4
Burak	4	22.10.2010	High school	High school	Absent	Absent	3
Cem	1	10.02.2010	University	Master	Available	Available	4
Duygu	-	15.03.2010	University	University	Available	Available	4
Ece	2	27.06.2010	Master	University	Available	Available	4
Gonca	1	18.08.2010	Master	Master	Available	Available	4

According to Table 2 presented above, it is seen that the number of siblings of the students is usually one or two and their birth dates are close to each other. However, Burak, from the participant students, differs negatively in terms of education level of his parents and having

internet connection and computer at home. Two of the students have been in the same class for three years, while the other ten students have been in the same class for four years.

Data Collection

The data of the study were obtained by using semi-structured interview technique, which is a flexible questioning technique, in order to reveal students' opinions and suggestions about mathematical modeling activities at the end of the activities applied to the students for nine weeks (Güler, Halıcıoğlu, & Taşgın, 2015). In the preparation of the interview questions, national and international studies related to the subject in the literature were examined. There were studies that asked the opinions of teachers, novice teachers and secondary school students about modeling activities, but since there was no study that took the opinions of primary school students about mathematical modeling activities, questions specific to the research were formed. In these questions, students' perspectives on mathematical modeling activities and suggestions for future modeling activities were tried to be revealed. Two experts from mathematics education and qualitative research were consulted for the validity and reliability of the interview questions. In line with these views, “What do you think about the problem you have solved?” instead of “What do you think about the contribution of mathematical modeling activities to mathematics teaching?” and “Were there any difficulties you experienced during the mathematical modeling activity? If so, can you share what these challenges are?” instead of “Can you tell me the positive and negative situations you encountered during mathematical modeling activities?” questions were asked.

In order to ensure the reliability of the interview questions, a pilot application was made to a student who participated in the modeling activities. No problems were encountered in the pilot application and it was determined that the questions were suitable for the purpose of the study. Semi-structured interviews, which were made after the activities carried out as a pilot application in the first semester, were held at the school where the students were studying. However, the semi-structured interviews held in the second term were held online through the Zoom program due to the Covid 19 outbreak. An interview environment was created in which students could feel comfortable and open-ended questions were asked to the students. Open-ended questions help the researcher's flexible approach to the subject and prevent important variables related to the researched subject from being overlooked (Yıldırım & Şimşek, 2013). Some of the questions asked to the students in the interviews are presented

below. The research questions are basically as follows, but the questions of the interview were differentiated in line with the answers from the students and "additional questions" were asked.

1-What kind of way did you follow for the solution of mathematical modeling activities?

2-What do you think about the contribution of mathematical modeling activities to mathematics teaching?

3-Could you tell us the positive and negative situations you encountered during the mathematical modeling activities?

4- Were the modeling activities and coursework suitable for your liking and preferences?

5-Do you evaluate group work and individual work during the activities?

6-Can you evaluate your view towards mathematics as a result of mathematical modeling activities?

For the interviews, first of all, the classroom teachers were contacted and the meeting schedule was created in accordance with the curriculum of the students. The meeting schedule and total interview duration are given in Table 3.

Table 3. *Meeting Calender and Total Call Time*

<i>Participant</i>	<i>Date</i>	<i>Time</i>	<i>Duration</i>
Eren	18.11.2019/09:15		36'
Serra	18.11.2019/10:00		25'
Selin	18.11.2019/11:10		32'
Mert	19.11.2019/09:00		27'
Kerim	19.11.2019/09:45		33'
İpek	19.11.2019/11:00		37'
Ali	07.05.2020/14:00		28'
Burak	07.05.2020/15:00		22'
Cem	07.05.2020/16:00		31'
Duygu	08.05.2020/14:00		24'
Ece	08.05.2020/15:00		27'
Gonca	08.05.2020/16:00		30'

Analysis of Data

Content analysis was used in the analysis of the data obtained in the study. The main purpose in content analysis is to bring together data in similar expressions within the framework of certain concepts and themes and present them with relevant explanations in a way that the reader can understand (Yıldırım & Şimşek, 2013). Before the data analysis, the audio recordings of the interviews were transcribed verbatim. These raw data are classified under a list of codes and themes created to make sense for the reader. Then, these themes were summarized and presented in an explanatory framework under three categories (Miles & Huberman, 1994). In order to ensure the reliability of the data obtained from the interviews, the coding and categorization process was repeated 15 days later by the researcher. Subsequently, the data collected by two field experts who have doctorate degrees in education and are experienced in qualitative research were analyzed in different places, coded and categories were created (Yıldırım & Şimşek, 2013). Afterwards, two experts and researchers who analyzed the data came together, discussed and re-evaluated on the points where the difference of opinion occurred. The differences between the agreed common themes were eliminated and a consensus was achieved in the codes and categories created in this way.

Findings

When the data obtained in this study were examined, the views of the students on the use of modeling activities in the teaching process were determined under 3 themes. These themes include the students' positive opinions about the application of mathematical modeling activities, their negative opinions about the application of mathematical modeling activities, and the "recommendations for how and application of modeling activities" to be applied in the future, based on the students' own experiences regarding the application of mathematical modeling activities in the teaching process.

Under the theme of "Students' Positive Opinions about Mathematical Modeling Activities"; The sub-themes "Contributes positively to mathematics learning", "Contributes positively to individual development", "Group work affects teaching positively" and "Will to take an active role" were formed. Under the theme of "Students' Negative Opinions about Mathematical Modeling Activities"; The sub-themes of "Unusual question structure", "Negative that will affect classroom management" and "Problems arising from conventional education practices" were formed. Under the theme of "Students' Suggestions for the Implementation of Mathematical Modeling Activities"; The sub-themes of "Suggestions for the

studies carried out before the application", "Suggestions for the application", "Suggestions for the presentation" and "Suggestions for associating with other courses" were created.

While creating sub-themes, codes with direct quotations obtained from student opinions were included. In the sub-theme "Contributes positively to mathematics learning"; There are codes for increasing interest in the lesson, associating mathematics with real life and developing a positive attitude towards mathematics. In the sub-theme "Contributes positively to individual development"; There are codes for increasing success in mathematics, the belief that problems can be solved, and ensuring permanent learning. In the sub-theme "Group work affects teaching positively"; development of social skills and belief codes that problems can be solved. In the sub-theme "willingness to take an active role"; The codes of expressing oneself better, fulfilling responsibility and helping each other are included. In the sub-theme "The question structure is unusual"; There are codes for questions being too long, not being able to associate solutions with real life, differentiating the correct answers according to the people, and not understanding the questions. In the sub-theme "Negative situations that will affect classroom management"; There are codes for not being used to group work, having problems, having noise in the classroom, and late answering of the questions by the teacher. In the sub-theme of "problems arising from conventional education practices"; There are codes for not asking these questions in the exams and for the course duration to be short. In the sub-theme "Suggestions for the studies carried out before the implementation"; There are codes to help us solve the activities and if we do it together as a group. In the sub-theme of "Suggestions for implementation"; more time should be given and we should choose the groups. In the sub-theme "Suggestions for presentation"; Everyone should submit and we should not be interrupted are included in the codes. In the sub-theme "Suggestions for associating with other courses"; It can be used in other courses and there are codes that will be difficult to use in other courses. The themes and sub-themes created from the findings obtained from the semi-structured interviews with the students are presented in Table 4.

Table 4. *Themes, Sub-Themes and Codes Obtained From Student Opinions*

<i>Theme</i>	<i>Sub-Theme</i>	<i>Code</i>
Students' Positive Opinions about Mathematical	Makes a Positive Contribution to Mathematics Learning	Increasing Interest in the Course Relating Mathematics to Real Life Developing Positive Attitudes Towards Mathematics

Modeling Activities	Contributes Positively to Individual Development	Increasing Success in Mathematics Lesson Belief That Problems Can Be Solved
		Ensuring Permanent Learning
	Opinions on the Positive Effects of Group Work on Teaching	Development of Social Skills The Belief That Problems Can Be Solved With Group Work
	Active Mission Request	Expressing Yourself Better
		Fulfilling Responsibility
		The Importance of Solidarity
Students' Negative Opinions about Mathematical Modeling Activities	Unusual Structure	The Questions Are Too Long Inability to Relate Solutions to Real Life Differentiation of Correct Answers According to People Not Understanding Questions
	Adverse Affecting Management	Unaccustomed to Group Work, Having Problems Having Noise in the Classroom Late Answering of Asked Questions by the Teacher
	Problems Caused by Traditional Educational Practices	Not Asking These Questions in Exams Short Lesson Duration
Students' Suggestions for the Application of Mathematical Modeling Activities	Recommendations for Studies Before Implementation Implementation Recommendations	Help us Solve Events Let's do it together as a group We must choose the groups More Time Should Be Given
	Presentation Suggestions	We must not be interrupted Everyone Should Submit It will be difficult to use in other lessons

Suggestions for Can Be Used In Other Lessons
 Associating with Other
 Courses

Students' Positive Opinions about Mathematical Modeling Activities

The positive opinions of the students about Mathematical Modeling Activities were grouped under four: "It contributes positively to mathematics learning", "It contributes positively to individual development", "group work affects teaching positively" and "willingness to take an active role". Students expressed different opinions under these themes, and the statements regarding these opinions of the students are given below, through direct quotations:

Makes a Positive Contribution to Mathematics Learning

The students expressed their views with expressions such as "increasing interest in the lesson", "associating mathematics with real life", "developing a positive attitude towards mathematics" under the theme of "It contributes positively to mathematics learning". The statements regarding these views of the students are given below with direct quotations.

Increasing Interest in the Course

Selin: I didn't like math very much before, I used to say it's so annoying, but after this activity started, my favorite subject was mathematics.

İpek: Normal math classes were a bit boring for me. Lessons with mathematical modeling sounded more fun.

Kerim: I did it with love. I was keeping a diary in the 2nd grade, I wrote there as my favorite subject is mathematics. I already loved mathematics, and I started to like it more because you made it fun by adding fun, and it was nice for me to have a contribution to my group... That's why I did it with pleasure.

Serra: Modeling activities are fun, I didn't realize how the time passed because they were more fun. The questions in the other test books were boring, so I was bored while solving them. Normal test books had simple but boring questions, here there were difficult but fun questions. I mean, it fit my criteria, it would be nice if it was a little easier, but it was a lot of fun, it was fine.

Some of the students stated that the modeling activities were fun and they enjoyed doing the activities with the expressions "my favorite lesson was mathematics", "the lessons with modeling are more fun" and "difficult but fun questions". The students, who stated that the test

books were boring, stated that the time passed quickly and the activities were suitable for their tastes and criteria.

Relating Mathematics to Real Life

Gonca: It seemed to me that these questions could really come up, so it made sense. I liked it very much, for example, the stork question can be encountered both in the spring and it was very entertaining for me, at the same time I learned something. The running race challenged me a bit. We didn't know whether we would choose the winner or the one with less time. While doing it in the group, Ece says "Let's choose the first one" Cem says "Let's choose another one". There was a bit of discussion, but we finally found the right way.

Duygu: I think the travel problem was difficult, but we had such a problem, we didn't know where to go, it was just like that. Also, the benevolent big-footed foot was very different. As everyone's feet were different, their height was also different. Personally, I loved the math class, but now I love it even more. Because the questions in the test may not be real sometimes, but your questions were real, and I understand better the situations that can be real.

Cem: I loved the math class, but sometimes it was boring. While solving the questions, I could not fully understand what it meant, 3 more than 5 minus or something did not make sense to me. But now it lies in your logic and the solution proposals have a justification. It's more fun when you explain why we did it this way. If I did math for a day, I wouldn't get bored in these activities.

It was observed that the students associated mathematics with real life during the implementation of the modeling activities, with the statements "it may appear in the spring months" and "now lies in your logic, there is a justification for the solution proposals". It was observed that the students were more willing to approach the activities carried out with examples from real life situations.

Developing Positive Attitudes Towards Mathematics

Mert: It has a positive effect on my math, and it's more fun than normal math. I wish we could continue this process, but we cannot. If we did, I would like to solve a few more questions.

Serra: I used to not be good at math, I didn't like it very much, it seemed like it was very challenging. But after the modeling activities, I loved it and my blood warmed up.

Burak: I did not like mathematics very much, I was also afraid that I would be wrong. Indeed, sometimes it was like that, I made a lot of mistakes in mathematics in the trials. But now I always start with math, I have some confidence in myself.

Ece: I used to love mathematics, but after modeling activities, I started to like it more. Besides, the questions were good, I knew what it was, I could guess the result. After these activities, math started to seem simpler to me because I understood what I was doing.

As can be understood from the statements above, some students stated that after the model building activities, "I liked mathematics after the modeling activities, my blood warmed up", "now I always start with mathematics, I have a little confidence in myself" and "mathematics has started to seem simpler to me". It appears that they have begun to receive

Contributes Positively to Individual Development

Students stated that modeling activities contributed to their individual development. Under the theme of positive contribution to individual development, his views were expressed as "Increasing success in mathematics course", "Development of affective skills" and "Ensuring permanent learning". The statements regarding these views of the students are given below with direct quotations.

Increasing Success in Mathematics Lesson

Ali: We had difficulties with these questions at first, but we can overcome these difficulties with group work. I think these activities are fun, you learn without realizing it, I think my math has improved. In particular, I gained practicality while doing transactions, and they gave us a lot.

Selin: Test books also help me learn, modeling activities also help me learn. But as we solved these questions, we were preparing for the future. What we learned made more sense.

Mert: This process helped me improve my math and taught me how to do math questions. It was fine for me to learn, and it helped us all improve in math. Yes, we could think of everything more detailed and faster in mathematics.

Students expressed that their success in mathematics lessons increased with expressions such as "I gained practicality while doing the operations", "We were preparing for the future" and "This process helped me to improve my mathematics". In addition to this, it was observed during the research that the students developed positive attitudes towards mathematics and their achievements increased with their own expressions.

Belief That Problems Can Be Solved

Cem: I was excited at first, then it started to feel fun. Our relationships with our friends became stronger, and we learned mathematics without realizing it.

Duygu: When I first read the questions, I was thinking how are they such different questions? It got easier as we solved it, we drew graphs, we drew tables, it was not at all like the questions we covered in the lessons, but I like it.

Ece: The activities application was very nice and fun. It was difficult at first, but as we did, we got used to it. Sometimes there were problems within the group, but we were solving them by talking. Everyone can get offended even in the normal class, but here a way to agree is sought.

Selin: In normal test books, there were simple but boring questions, here there were difficult but fun questions. I mean, it fit my criteria, it would be nice if it was a little easier, but it was a lot of fun, it was fine.

Above; It is understood from the expressions "our relations with our friends have become stronger", "we had problems but we were solving them by talking" and "everyone can get offended in the classroom, but a way of understanding is sought here", it It is understood that the students' affective skills towards mathematics improved during the modeling process. The students stated that this development was more evident as the process progressed, and that they had difficulties in the activities in the first weeks, but they adapted in the following weeks.

Ensuring Permanent Learning

Burak: These activities were very good for learning mathematics. We started to learn more meaningfully, sometimes we had difficulties, but this made us think and think... As we thought, everyone came to different ideas and solutions.

Ece: These questions are very different and fun, while solving other questions, the same things happen like a machine. I may not remember the questions we solved in the lessons, but your questions always stay in my mind, I always remember the procedures and stuff. So you're arguing here, different things happen. Sometimes what you think is right isn't right, but it's fun.

Gonca: It's not like the others, so the math is the same, you're actually doing the same, different models can be encountered in real life. But others find it a little difficult, it would be more understandable if they were like this. Our teacher Harun was telling us that we needed to solve the test immediately. There is no test here, we learn by understanding a little more, it is fun.

It is understood that the students stated that learning is more permanent from the statements above, "we started to learn more meaningfully", "but your questions always stay in my mind" and "there is no test here, we learn with a little more understanding". In addition, students stated that modeling activities were more memorable, unlike routine math problems.

Opinions on the Positive Effects of Group Work on Teaching

The students who participated in the study stated that the group work applied in the modeling activities contributed positively to the teaching of mathematics. Under the theme that group work affects teaching positively, his views were expressed as "development of social skills" and "the belief that problems can be solved with group work". The students' views on this theme are presented with the direct quotations given below.

Development of Social Skills

Serra: Modeling activities were good for my love of mathematics, group work was also good. It also made a difference to the school, it was our last year, I got closer with İpek and so on. It had such advantages and disadvantages.

İpek: At first, Serra and Kerim had a little fight, but as they progressed, they started not to fight and got along better. I was a little more shy in the first weeks, I wasn't solution-oriented, to be honest, but as I progressed towards the end, I produced more ideas and my shyness went away a bit. The activities are good fun, besides, we generate ideas so that our shyness is relieved and we have fun, we do group work.

Cem: We never played with them. We were always hanging out with boys and girls separately. I became better friends with them in this group. Then we did better work as a group than individually.

The statements of some students, whose opinions were taken, "I got closer with İpek", "I got a little bit more shy" and "I became better friends with them in the group" reveal that the students' social skills improved and they established better relationships with their friends during the modeling process.

The Belief That Problems Can Be Solved With Group Work

Eren: My teacher, when you work individually, other people's ideas are not yours, but it is not like that. Because sometimes we need the opinions of others. For example, when it comes to the things we don't know as a group, I don't know, Selin, for example, but Mert can; For example, Mert can't know, Selin can't, I can. That's why group work is more fun and enjoyable.

Serra: It was difficult at first, but as it progressed, it became fun and instructive. Also, group work is better. The longer the question, the more time it took to spend, and the things inside the question were the same. We saw a difference here when we always go from 5 marbles to 10 marbles. That was nice too. Mathematical modeling activities would not be nice if they were one by one. We did it one by one. I think it would not be very nice if we did everything that you probably wanted to measure, what you did for him, one by one.

Selin: I realized that I have a little more difficulty individually, I was doing the questions better as a group. But I can also say that the questions we solved individually were a bit easier for me. It might be because we are not a group, the "Car" question, the "Sille Park" question was one click easier. Group work helped our self-confidence a little more, that is, it helped our entrepreneurship a little, and it also improved my relationship with my friends. There were sometimes discussions within the group, we had a little difficulty because of it, but everyone defended their ideas and we accepted the good thing.

It can be understood that some students' belief that group work can solve the activities more efficiently is understood from the statements "group work is more fun and enjoyable", "modeling activities could not be better if they were done individually" and "I had a little more difficulty individually, I was doing better as a group".

Active Mission Request

During the study, the students wanted to take an active role in the preparatory work, modeling practices and group presentations. Students expressed their willingness to take on a task with expressions such as "expressing oneself better", "fulfilling responsibility" and "importance of helping each other". The students' views on this theme are presented with the direct quotations given below.

Expressing Yourself Better

Kerim: I am no longer looking for simple ways, but ways that will never happen, but ways that few people will think of.

Eren: We used to be a little afraid to try to do it, but now we sometimes argue so we can do it. In the past, our discussion was "you do this, you do that", now our discussion is "I will do this, I will do that" and it is very entertaining.

Burak: I think the questions were easier in the first weeks. For example, bazaar was easy, picnic was easy, but we did not understand. In the following weeks, we got used to the group, understood the questions, and made it easier. The olive question was very difficult, but the pontoon question was very difficult, but we expressed our thoughts well, nevertheless we did it with difficulty, everyone in the group was carrying out an opinion.

As can be seen from the direct quotations above, it is understood that some students are looking for ways to express themselves better by saying "I am looking for ways that few people will think of" and "The pontoon question was very difficult, but we expressed what we had in mind well".

Fulfilling Responsibility

Duygu: I had difficulties with some questions, but my friends helped me. In the first weeks, we didn't know how to work with groups, everyone seemed like an individual again. In the following weeks, we became a group with the division of labor, and everyone fulfilled their responsibilities.

Cem: For example, the groups found storks differently. Also, we didn't want to present it in the first weeks, everyone was saying that you could present it. But then we were encouraged and wanted to present, which was one of our duties. So you liked our presentation, and we have confidence in ourselves.

Eren: At first, we didn't really understand. Selin, Mert, I thought the questions would be normal math questions. We said that it would be multiplication, division, addition, subtraction, but when it was different like this, we got a little excited and scared, but you don't need to be afraid, it has been very good until now when we have done our duties.

Throughout the study, students were given three basic responsibilities. The first responsibility is to do research in accordance with the context before the activities, the second responsibility is active participation in group work, and the third responsibility is to present the

solution to the class. It is understood that the students want to fulfill their responsibilities from the expressions "We became a group with the division of labor in the following weeks, everyone has their responsibility" and "then we were encouraged and wanted to present it".

The Importance of Solidarity

Ece: For example, there was a sorting, we were writing the same ones in the same color; There was the question of cities, and the transactions seemed easy, but it was important which operation we would do. The division of labor was necessary because time might not be enough.

Duygu: We had difficulties in some situations, but eventually we overcame it by discussing the questions seemed a bit difficult, but later we got used to it. I had problems with the transaction, sometimes I made mistakes while trading; my friends taught me through group work. I don't have many problems anymore, but we need to keep these activities going.

Gonca: The activities started to seem simple, so I came up with different ideas. I also had the courage to myself, so I got on better with my friends. The ones that were done alone were difficult, but the ones that were done with the group started to come easier. At the presentations, we did not want to present at first, but then we were very eager to present. We had difficulties, but we solved it with the help of our friends in the group. In the first question, I did not understand exactly what he wanted, which car should we rent, but maybe it would be better if I had friends.

Undoubtedly, one of the important elements of group work is helping each other. It is seen that the students helped each other with the statements "The division of labor was necessary because time might not be enough" and "My friends taught me through group work". When the answers to all the questions given by the students are examined holistically, summary information about the positive opinions is presented in Table 5.

Table 5. Frequency table of Students' Positive Opinions

Opinions	Frequency(f)
Increasing interest in the course	23
Relating mathematics to real life	21
Developing positive attitudes towards mathematics	19
Ensuring permanent learning	14
Expressing yourself better	11
Development of social skills	10
Increasing Success in mathematics lesson	9
The belief that problems can be solved with group work	9
Belief that problems can be solved	5
Fulfilling responsibility	3

The importance of solidarity	1
Total	125

As can be understood from the Table 5. 125 positive opinions under 11 headings were given by the students about the mathematical modeling activities. Students' most common positive opinion on mathematical modeling activities is 'Increasing Interest in the Course'. This positive opinion was expressed 23 times by the students. The second most frequently repeated positive opinion is 'Relating Mathematics to Real Life'. It was used 21 times by the students. The least reported positive opinion about mathematical modeling activities is 'The Importance of Solidarity'. This positive opinion was expressed one time by the students. The second least reported positive opinion is 'Fulfilling Responsibility'. This positive opinion was expressed three times by the students.

Students' Negative Opinions about Mathematical Modeling Activities

Negative opinions of students about mathematical modeling activities were grouped under three themes: "Unusual question structure", "Negative situations that may affect classroom management" and "Problems posed by the education system". Under these themes, the students expressed different views and the statements of the students regarding these views are given below, through direct quotations:

Unusual Question Structure

All students participating in the study had not encountered mathematical modeling activities before, but students attending Science and Art Centers encountered this type of question structure. Students stated that modeling activities are different from natural learning environments; They were conveyed with expressions such as "the questions being too long", "not being able to relate the solutions with real life", "differentiation of the correct answers" and "not understanding the questions". The students' views on this theme are presented with the direct quotations given below.

The Questions Are Too Long

Duygu: Modeling questions are very different, these questions are too long at first, you think you didn't understand towards the end, you read them again. These activities are definitely more fun, but they are a bit long, they need to be read again when we do not understand. It's a bit boring to be long, but when you learn by having fun, you don't understand how time passes.

Cem: We are not used to working with groups, but group work is needed here. Because the questions are both very long and like other questions, how much does it cost, not how long, but questions that we need to interpret a little more. Teacher Harun sometimes makes us solve such long questions, but it wasn't that long.

Ece: We thought it would be difficult when the question was too long, as if we were taking the university entrance exam. In fact, when we were talking with friends after you, we were saying to each other if there would be such a question.

Selin: At first I couldn't start from somewhere, we didn't know where to start because the questions were too long. Our other friends were not talking until one of us said something and put forward an idea.

Modeling activities are longer than multiple-choice applications that students solve in natural learning environments. Students expressed this difference with the statements “the activities are definitely more fun but a little longer”, “like other questions, how much does it cost, not how long” and “The question is too long as if we are taking the university exam”.

Inability to Relate Solutions to Real Life

Eren: At first, we had a little difficulty because we didn't know much, we saw it for the first time anyway. We didn't do anything when we couldn't relate the logic to the 4 operations. So we did not know exactly how many storks would come. When I went to Bilsem, we did some of these transactions.

Mert: First we read the question, after everyone read it, we took turns saying our thoughts about the question. After that, we were starting to solve the question, but it didn't seem to make sense in some solutions.

Duygu: It can be boring when you don't understand. But in general, it was good, I mean, it was easy to understand the questions after understanding, but it was difficult to relate the questions to life.

Students especially had difficulties in associating activities such as "Giant Foot" and "Uncle Farmer Hüseyin" with real life situations. They stated this difficulty with the statements “So we did not know exactly how many storks would come” and “But it was difficult to relate the questions to life”.

Differentiation of Correct Answers According to People

Cem: We need to think a little more about these questions, we need to comment. Because different answers can be correct. We were faced with such a question for the first time in the first weeks, while we were discussing it in the group, we were trying to reach the result by doing the operations with numbers immediately. But as we did the activities, we realized that there was no one correct answer, different answers could have been correct.

Selin: Something like this was happening in the classroom, we could create several more questions out of one. But in these activities, we had to focus on one question, that is, differently, if we compare.

İpek: One of the most challenging situations for us is I say let's do it like this, Kerim says let's do it like that. It was a little difficult for us to come to an agreement, but we were able to come to an agreement when we persuaded. Everyone's answer sounded right, but we knew we had to make one at the presentation.

The correct answers differ due to the nature of mathematical modeling activities. During the application, the students gave different answers to the activities. They explained these different answers with the expressions "there was not one correct answer, different answers could have been correct" and "everybody's answer was right for himself".

Not Understanding Questions

Ece: These activities were not like the other activities we solved in the lesson, they were a bit difficult, but they were fun to solve. We had to think a little bit, so we had to work our heads a little bit. We have to be very careful in the lessons where we solve these activities. There are fine details. Did we miss that point, you can solve the question, but it can be wrong. We need to be careful, we need to be careful in other lessons, but a little more attention is needed in these activities.

İpek: I was having a hard time understanding some problems. That's why, as a group work, I listened to what my friends said, sometimes I could not come up with ideas, sometimes I was producing, there were no other difficulties.

Selin: I told you, sometimes we were even angry with you. These are high school questions, how can we do it, for example, we were solving a question in an hour. We didn't understand it at first, this was the bad part, it took a long time and it was difficult.

Cem: We had a little difficulty at first. How are these questions, how do we do it, we were biased at first. But especially I was having this problem, I don't know where to start. When we first started, we couldn't start from anywhere, but as we progressed, we started to get used to the problems.

The long modeling activities made it difficult for students to understand the question. The students expressed this difficulty with the expressions "we need to be very careful, there are fine details", "I was having trouble understanding some problems" and "these are high school questions, how should we do it".

Adverse Situations Affecting Classroom Management

It was observed that the students participating in the study had problems with classroom management since group work was not carried out in natural learning environments, and these problems were expressed by the students in the interviews with the students. These problems experienced by the students are explained with direct quotations under the headings of "not being used to group work, having problems", "noise in the classroom" and "late answering the questions by the teacher".

Unaccustomed to Group Work, Having Problems

Ali: The first weeks were difficult, but once I got used to it, I saw that it was easy. If we teach like this, we will get used to it more, it will be easier. Also, we cannot work with groups, we are not used to group work. And the feeling was always saying something "let it be what I say". I was always used to working individually, we sometimes had problems in group work; Duygu Ece was talking to each other.

Selin: They had a discussion on the pontoon question, and we lost some time there on whether to tie the rope or not, but we do not experience these individually. But still, I prefer group work. Something like this happened as a group, in the group work we did towards the last weeks, Selin and Mert had a fight, which we do not experience individually.

Ece: When you do it in the group, everyone wants their opinion to be valid, but we were discussing, I think it's fun but a little difficult. There were also problems between our group in the first weeks, who did not know what to do. We never do group work in the classroom. In fact, it better be when we play outside, we only become a group, we solve tests in lessons, we do it individually too.

The students participating in the study had difficulties in getting used to group work in the first weeks. However, they overcame this difficulty, albeit partially, in the following weeks. It can be understood from the statements "We sometimes had problems in group work", "Selin and Mert had a fight, we do not experience this individually" and "There were problems between our group in the first weeks".

Having Noise in the Classroom

Ece: We are asked questions in the class, we try to solve them, sometimes there are long questions, but we do not need to think much like yours. If we think about these questions, we can think of different solutions. But it is a little difficult to think in a noisy place.

Cem: Like other lessons, we were reading right away, then we were trying to solve it, but we had difficulties. First we thought, then we read. We used different colored pencils to see what we could do. Even when we were doing this, we couldn't do it silently, there was a bit of confusion in the classroom.

Eren: At first, we had difficulties in individual and group work as we did not know modeling, but later on, as we got used to it, those problems began to come very easily. Some of them immediately started talking among themselves without thinking of other ways and there was a lot of noise in the classroom.

While the activities were being solved in group work, the discussions among the students caused noise. In the interviews, the students reflected these noises with the statements "But it is a little difficult to think in a noisy place", "We can't be quiet, there was some confusion in the classroom" and "He started talking among himself and there was a lot of noise in the classroom".

Late Answering of Asked Questions by the Teacher

Selin: At first, we were doing this, we were reading the question, we were underlining it, we were understanding the question. We were having a consultation among ourselves and we were starting to plan, usually we were either graphing or comparing. We were trying to ask you about the points we did not understand, but it was not our turn, we were waiting, time passed and then we forgot our question.

Serra: In the first weeks, there was an adjustment problem, we were all saying something. Everyone was following what they said, not obeying what others said. There were disagreements, sometimes you and Aysun teacher were looking at other groups, it was our turn to be late. Kerim was puffing and puffing...

During the application, there were cases where the students' questions were answered late due to the answers to the questions of other groups. Some of the students participating in the research were asked to answer the questions late: "We were trying to ask you about the points we did not understand, but it was not our turn" and "it was late. Kerim was puffing and puffing, so..." they stated.

Problems Caused by Traditional Educational Practices

Students, who have not encountered modeling activities before, have problems that may arise from our education system during the application. They stated that "these questions do not appear in the exams" and "the course duration is short".

Not Asking These Questions in Exams

Kerim: For example, there was unnecessary information, we couldn't capture that information, we couldn't figure out its logic. In our other mathematics, there was not much unnecessary information. We will enter the scholarship this year, I think they do not have such questions, I would do it, but in those exams there are questions like our other mathematics course.

Selin: Because if I do a question in an hour in the exam, I will get zero for sure. If there is 1 question in the exam and 1 hour is given, then I can do it in an hour, I can do that.

Some students explained that modeling activities are different from other types of questions by saying "we will enter scholarships this year, I don't think they will have such questions" and "if I do a question in one hour in the exam, I will get zero for sure".

Short Lesson Duration

Ali: If we had a little more time, we could have found different answers. When we got used to it, we started to use time well in the last few weeks, and we did a division of labor.

Burak: My friends were very good. We were listening to each other, we weren't listening at first, but later on, we listened to each other in the events that

followed. There was a lot of time, but it seemed short to us, we learned to use it effectively towards the end.

Cem: We are not used to working with groups, but group work is needed here. Because the questions are both very long and, like other questions, not how much it costs, but how long it is, but the questions that we need to interpret a little more. Your questions should be at least 1 hour, but our lessons would be better if 40 minutes.

Although the students were given 50-60 minutes on average for the solution of the activities, some students said that the time should be longer, "If we had a little more time, we could have found different answers", "the time was too much, but it seemed short to us" and "the lessons would be better if 40 minutes." will happen". When the answers to all the questions given by the students are examined holistically, summary information about the negative opinions is presented in Table 6.

Table 6. *Frequency table of Students' Negative Opinions*

Opinions	Frequency(f)
The questions are too long	18
Unaccustomed to group work	14
Not asking these questions in exams	12
Inability to relate solutions to real life	11
Short lesson duration	7
Having noise in the classroom	4
Differentiation of correct answers according to people	4
Not understanding questions	3
Late answering of asked questions by the teacher	2
Total	75

According to the Table 6. 75 negative opinions under nine headings were given by the students about the mathematical modeling activities. Students' most common negative opinion on mathematical modeling activities is 'The Questions Are Too Long'. This negative opinion was expressed eighteen times by the students. The second most frequently repeated negative opinion is 'Unaccustomed to Group Work'. This negative opinion was expressed fourteen times by the students. The least reported negative opinion about mathematical modeling activities is 'Late Answering of Asked Questions by the Teacher'. This negative opinion was expressed two times by the students. The second least reported negative opinion is 'Not Understanding Questions'. This negative opinion was expressed three times by the students

Students' Suggestions for the Application of Mathematical Modeling Activities

While the students were evaluating the modeling process, they were grouped under three themes: "recommendations for the work done before the application", "recommendations during the application" and "recommendations for the presentation" . Under these themes, the students expressed different views and the statements of the students regarding these views are given below, through direct quotations:

Recommendations for Studies Before Implementation

Before the activities, students were asked to do research in accordance with the context of the activity to be held that week as a preparatory work. The opinions of the students regarding these studies were determined as "let's do it together as a group" and "help us solve the activities".

Help us Solve Events

Eren: We did the kermis problem first, we had a little difficulty with it since it was the first. At first, I was very excited about it. Our previous work was good, it was guiding us and helping us.

Selin: At first we were reading, it seemed like it was difficult for us, then as we read the problem one by one, we knew that we had to start from somewhere, we solved the problem in this way. The homework you gave us was very useful for us, sometimes we searched the same site, it was revealed, for example, it was the case with storks.

Ali: We were reading first to solve it, but generally we had difficulties, we were looking for a clue, what should we do to solve this. The most important clue was the work you gave earlier. I did not know exactly where olives grow, migratory birds come according to light pollution, I learned these, it helped me to solve the questions.

Some students' statements such as "it was guiding us, it was helping us", "the homework you gave us was very useful" and "the most important clue was the work you gave before" reveals that the work done by the students before the activities helped them solve the activities.

Let's Do It Together as a Group

Selin: At first, our group friends ask, we all read, then one of us, this is usually me, reads the question aloud, and then we highlight important information while reading aloud. Everyone who had researched Selin from another place and Mert from another had different knowledge. I could hardly explain the golden ratio to my friends. For example, Mert has seen a tractor before, but we don't know exactly how big it is, we can do it better if we know.

İpek: You were asking questions for a solution, and we were answering them. We were also underlining and stating important points, and we were following the

path according to the important information given. We came up with an idea to measure our waist widths in the big foot problem. But everyone was saying something different, it would be better if we looked from the same site.

Burak: I say that baklava is not cheap because my mother buys it for a tiny 50 lira. But others say it will be cheap, in fact, if they knew, they could do it right. Also, if everyone's knowledge is different, if we are of the same mind, the solution may be easier.

Some students stated that the preparatory work done before the activities should be done together by the group members with the expressions "Everyone who has researched from another place, Mert has different knowledge", "It would be better if we looked from the same site" and "The solution would be easier if we were of the same mind".

Implementation Recommendations

Students' suggestions for practice are explained with direct quotations under the headings "We should choose the groups" and "More time should be given".

We Must Choose The Groups

İpek: There were disagreements in the groups, but as we progressed, we were able to get along better and generate more ideas. It would have been better if we had the groups, especially if we were chosen able to solve better questions, depending on group work. Sometimes there were disagreements in our group.

Serra: I know you created the groups, but there were disagreements in some groups other than ours. Even Senalar had problems while solving, they did not want to present the running race that week. In fact, it would be less of a problem if we created the groups beforehand. Everyone can get along better.

Eren: In the first week, I had even more difficulties in the individual work since there was no group, then in the last weeks individual work started to come easy, the easiest and most beautiful was the group work in the last weeks. Working as a group was good, but when you can't get along, he says get what I say and the other says get what I say. But we find the right way, this time too, time is passing, I think time is very important in these events.

During the study, it was observed that the students worked in harmony. However, this situation, in which some students could not agree within the group, was reflected in the students' opinions with the statements "it would be better if we chose the groups" and "actually, it would be less of a problem if we formed the groups beforehand".

More Time Should Be Given

Eren: I think it is a very nice and enjoyable event, even though it was a bit difficult at first. But time was not enough, and we were getting excited and wasting time because we didn't know what to do. Time seems like a lot compared to other questions, but when these questions are different, time sometimes does not reach.

Gonca: First, we were reading the question silently, then everyone was saying their own opinion. But there was usually an argument here. It was a waste of time.

Cem: When we didn't understand what we were reading, we would ask our friend, he was telling his opinion, and if what he said was logical, what he said was true. But Duygu was not convinced and we were always arguing. Our procedures were not difficult, but it took time for him to understand the question. The most difficult part was understanding what was asked in the question.

It is understood that some students, who could not use time well in the first weeks of the study, stated that "we were excited because we did not know what to do, we were wasting time" and "our procedures were not difficult, but it took time to understand the question".

Presentation Suggestions

The students presented the solutions they reached during the activities to their friends. The suggestions of the students for the presentation stage were stated under the headings "We should not be interrupted" and "Everyone should present".

We must not Be Interrupted

Serra: We were mostly trying to find the result by sharing each other's ideas and then adding, dividing and multiplying. During the solution, everyone was arguing, but in the end, especially some of our friends were interrupting us. In fact, if he had listened to us, he would have understood what we were saying, but he was hastily interrupting us.

Ece: While our group was presenting, we couldn't have a good division of labor. Actually, our presenter was clear, but friends or something intervened, and it wasn't appropriate. But we did it anyway, you said so you wouldn't interrupt your friends, but there were some who didn't comply.

Cem: Sometimes there were situations that we did not understand, but we were able to deal with it by talking to our friends. At first, we didn't want to make a presentation, we were hesitant. Just as we are explaining the question, Emre was intervening, it was getting on our nerves, but in the following weeks, everyone was respectful to each other.

The stage of presenting the solution that the students have reached is an important dimension of the study. However, presentation activities of students in natural learning environments are not used. The students emphasized that their words should not be interrupted during the presentation with the expressions "especially some of our friends were interrupting us", "You said so as not to interrupt your friends, but there were some who did not comply" and "just we are explaining the question, Emre (a student in the class) was interfering".

Everyone Should Submit

Eren: our p 's hardly happened in the first week but now we understand problems in recent weeks, we have made many beautiful prepare the presentation of each problem is also very nice. We were wondering how others solved it. It would be nice if everyone presented it, but there might not be enough time for it.

Serra: Some of our friends' presentations were the same as ours, while others were very different. The problems were fun, we were arguing amongst ourselves after you left, about who is more logical, etc. But I think it would be nice if there was another lesson for the presentation.

Cem: To be honest, we didn't hesitate when playing during regular recess, but we were hesitant in presentations. Afterwards, we did not hesitate, everyone wanted to present. I was wondering how many storks they found, how many trees they planted. It would be nice if they also made a presentation.

The students stated that the solution reached should be presented by all students with the expressions “We were wondering how others came up with the solution”, “We were arguing about who made more sense” and “It would be better if they also made a presentation”.

Suggestions for Associating with Other Courses

When the students were asked whether mathematical modeling applications could be used in other courses, some students stated that they could be used, while others stated that they could not be used.

It Will Be Difficult to Use In Other Lessons

Serra: Maybe in other math classes, but maybe in social or something like this, there will be no group work, maybe there will be no projects. I don't think it's possible in math either, because we're solving tests, it should be one in general.

Duygu: Maybe it's group work, but it might not be such a presentation. It's not boring, sometimes I stay between the choices in other math lessons, but the answers should be clear here.

Students who stated that mathematical modeling applications could not be used in other lessons expressed their opinions with the statements "Maybe there will be no group work in social or something like this" and "There may be group work, but there may not be such a presentation".

Can Be Used In Other Lessons

Serra: Now what I'm about to say may not be in math, it may be in fun. Maybe we could do something now, like making a poster and painting it as a decoration. I think modeling activities were fun, whether they were both a little bit, as in the lesson and modeling activity, but it can also help us to understand it differently, we may need to understand it differently. We may also need the way that Aysun teacher told us.

Selin: Let the normal classes be like that, but not the exams. In fact, I would like to continue this kind of work in secondary school, it is very nice.

Kerim: So these are fun, you make them fun, you other math teachers don't make it that fun. It can also be in science, which is a numerical course, we can compare the subjects, and we can study this subject because it is more difficult or that subject is more difficult.

Gonca: Sometimes it was hard, but mostly it was fun. It's like we're bringing together other lessons, that is, we understand Turkish, we do mathematics. These were fun but difficult when I couldn't solve them. We needed the ideas of our friends to solve them.

Some of the students who participated in the study stated that mathematical modeling applications can be used in other lessons as well, "as in the lesson and modeling activity," and "Let the normal lessons be like that, but not the exams". When the answers to all the questions given by the students are examined holistically, summary information about the suggestions for the application of mathematical modeling activities is presented in Table 7.

Table 7 Frequency Table of Students' Suggestions for the Application of Mathematical Modeling Activities

Opinions	Frequency(f)
More time should be given	21
Help us solve events	17
We must choose the groups	9
Let's do it together as a group	7
We must not be interrupted	6
Everyone should submit	4
It will be difficult to use in other lessons	4
Can be used in other lessons	2
Total	70

As can be understood from the Table 7. 70 opinions under eight headings were given by the students about the application of mathematical modeling activities. The most common opinion of applying mathematical modeling activities is 'More Time Should Be Given'. This opinion was expressed 21 times by the students. The second most common opinion is 'Help us Solve Events'. This opinion was expressed seventeen times by the students. The third most common opinion is 'We must choose the groups'. This opinion was expressed nine times by the students.

Conclusion and Discussion

The aim of this study is to reveal how elementary school 4th grade students perceive these activities as a result of mathematical modeling activities and their opinions and evaluations about the application process in the learning environment. The findings show that; Primary school 4th grade students expressed their "positive" and "negative" views on mathematical modeling activities, as well as suggestions for future modeling activities.

Students expressing positive opinions; They stated that mathematical modeling activities affect mathematics learning positively, contribute to their individual development, and group work affects teaching positively. This result of the study can be found in the literature (Tekin-Dede and Bukova-Guzel, 2013; Güder, 2013; Deniz and Akgün, 2014; Tutak and Güder, 2014; Işık and Mercan, 2015; Bilen and Çiltaş 2015; Işık and Mercan 2015; Urhan and Dost, 2016; Pilten, Serin and Işık, 2016; Deniz and Akgün, 2017; Şahin and Eraslan, 2019). In addition, one of the results reached in this study, which is not mentioned in other studies in the literature on the subject, is that the students want to "take an active role" during the applications. Primary school students' willingness to take part in modeling activities can be explained by the fact that they do these activities fondly and willingly. As it can be understood from these views, the students did the modeling activities with love and fun. Students' interest in the lesson has increased and their relationships with their friends have improved. In addition, in the presentations made after the activities, the students had the chance to express themselves better.

Some students, who expressed negative opinions about the application process of mathematical modeling activities, stated that they were not accustomed to the question structure applied in mathematical modeling activities. It was concluded that the students approached the questions with an unusually long structure with prejudice and had difficulty in understanding the long question structure. In addition, the inability to associate the solutions reached with real life and the fact that the correct answers differ according to the group members are among the negative opinions of the students towards the question structure. Another negative view of students towards practice is the problems experienced in classroom management. The fact that the students were not accustomed to group work caused them to have difficulties in practice. Şahin and Eraslan (2019) also stated that the students had difficulty in working in groups in the study in which they took the opinions of the pre-service teachers. The presence of noise in the classroom as a result of the creation of a classroom arrangement different from the natural learning environments during the applications, the late answering of the questions directed to the teacher by the group are among the negative opinions of the students towards

the implementation of the modeling activities. The students gave negative opinions about the modeling practices because the lesson time in natural learning environments was limited to 40 minutes and questions were asked in a different structure from the modeling activity in the exams. In the literature, there are studies stating that modeling activities are not used in lessons because it takes a lot of time. (Akgün et al., 2013; Ören Vural et al., 2013; Tutak & Güder, 2014; Pilten, Serin & Işık, 2016; Şahin & Eraslan, 2019).

One of the results of this study is the students' views on the implementation of modeling activities. The students stated that it helped them to solve the activities related to the work done before the application. When the relevant literature is examined, Tekin-Dede and Bukova-Guzel (2013) also concluded that the studies given before the activity affected the modeling process positively. According to the results of this study, it was concluded that it would be more efficient for students to do the work given before the activities together. The students stated that it would be more beneficial for them to choose the groups for the implementation process of the modeling activities and that more time should be given to the implementation period. Similar to this result of the research, it was emphasized in the studies of Güder (2013), Karalı (2013) and Tutak and Güder (2014) that the students were not accustomed to modeling activities and that the time given was insufficient. In the opinions about the student presentations, the students who stated that all the solutions reached by the groups should be presented, stated that their words should not be interrupted during the presentation. It is thought that starting student interactions in the research process before group work will contribute positively to the activities. In terms of associating mathematical modeling activities with other lessons, some of the students stated that mathematical modeling activity could be used in other lessons, while some students stated that it could not be used especially in verbal lessons. From the students' opinions, it was concluded that besides the application of preparatory studies and group activities in other lessons, it would be beneficial to use modeling activities in mathematics lessons.

Suggestions

The results of this study are limited to the opinions of 12 students selected among 64 students attending 4 classes in a state primary school. Considering the possibility of different results, the number of students whose opinions are taken can be increased. Studies based on mathematical modeling activities, which have been done frequently at undergraduate, high

school and secondary school levels in recent years, can be applied more intensively to primary school students in order to prepare students for these levels.

It is thought that it would be beneficial for teachers to have experienced these practices in order to effectively implement mathematical modeling activities in the classroom. In this context, seminars and workshops on mathematical modeling should be given to teachers. In these activities, modeling examples that primary school teachers can apply in their classrooms should be created. It is thought that national and international projects to be carried out on the subject will be similarly beneficial for the dissemination of modeling activities in primary schools.

In addition to the modeling activities to be created by the teachers, materials and resources should be provided for the creation of modeling activities suitable for the subjects included in the primary school mathematics curriculum. With this understanding, well-arranged modeling activity examples should be included in mathematics textbooks and teacher guidebooks.

Undoubtedly, it is beneficial to carry out modeling activities with a seating arrangement that is different from the usual classroom seating arrangement. It is recommended to carry out modeling activities in classrooms where group work can be done, a seating arrangement can be provided and there are computers, projections and interactive boards.

The modeling activities to be created should be selected from areas where data can be collected about the problem situation, in accordance with the real-life situation, where they can determine the relations between the variables and the accuracy of the solution reached can be checked. In addition, it is recommended that the activities be created from the contexts of the students' living spaces. The fact that the studies done by the students before the activities and suitable for the context of the modeling activity are carried out separately by each student leads to the prolongation of the discussions during the activities and the inefficient use of time. It is recommended that students do the work given before the activity together in the designed learning environments.

Title in Turkish

Özet:

Matematik öğretiminin temel amaçlarından biri de öğrencilerin gerçek yaşam problemlerini çözmeleri ve gerçek yaşam durumu ile matematiği ilişkilendirmelidir. Matematik öğretiminin kolaylaştırmanın bir yolu olarak derslerde gerçek yaşam problemlerinin matematiksel modelleme etkinlikleri ile uygulanmalıdır. Bu çalışmanın amacı 9 hafta süresince matematiksel modelleme etkinliklerini deneyimleyen ilkökul 4. sınıf öğrencilerinin modelleme etkinliklerine yönelik görüşlerini ve ileride yapılacak modelleme etkinliklerine yönelik önerilerini belirlemektir. Çalışmanın katılımcıları 2019/2020 eğitim öğretim yılında Konya’da bir devlet okulunun 4. sınıfına devam eden 69 öğrenci arasından amaçlı örnekleme yöntemi ile belirlenen 12 öğrencidir. Çalışmanın verileri öğrencilerle gerçekleştirilen yarı yapılandırılmış görüşmelerden elde edilmiş olup içerik analizi ile çözümlenmiş ve yorumlamıştır. Çalışmanın sonucunda öğrenciler; matematiksel modelleme etkinliklerinin derse olan ilgilerini artırma, matematik derslerinde başarılarını artırma ve sosyal becerilerinin gelişmesi gibi olumlu görüşlerin yanında soruların uzun olması, grup çalışmalarında yaşanan sorunlar ve sürenin yetmemesi gibi olumsuz görüşler de belirtmiştir.

Anahtar kelimeler: Matematiksel Modelleme, Model Oluşturma Etkinlikleri, İlkokul, Öğrenci görüşleri, Öğretim deneyi,

About the Author

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Yazar Pamukkale Üniversitesi Sınıf öğretmenliği(2003) bölümünü tamamladıktan sonra Selçuk Üniversitesi eğitim yönetimi ve teftişi alanında yüksek lisans derecesini (2010) almıştır. Doktora eğitimi ise sınıf eğitimi alanında (2021) tamamlamıştır. Araştırma alanları arasında matematik eğitimi, matematiksel modelleme etkinlikleri ile matematik öğretimi, rutin olmayan problem çözme stratejileri, matematiğin oyunlaştırılması ve teknolojik araçların matematik öğretiminde kullanımı bulunmaktadır. Yazar 19 yıllık öğretmenlik deneyimi boyunca farklı öğretim yöntem ve stratejileri kullanarak özellikle Matematik dersini öğrencilerine aktarmaya çalışmıştır. Sınıf öğretmenlerine ilkokullarda Matematiksel Modelleme uygulamaları ile ilgili hizmet içi eğitimin yanında, 225021 ID Numarası “Math Fundamentals” e-twinning projesi kapsamında “Uygulamalı Matematiksel

Modelleme” semineri vermiştir. Yazar matematik bağlamı olan farklı sempozyum ve kongrelerde bildiriler sunmuştur.

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References

- Akgün, L., Çiltaş, A., Deniz D., Bayrakdar Çiftçi, Z., & Işık, A. (2013). İlköğretim matematik öğretmenlerinin matematiksel modelleme ile ilgili farkındalıkları. [Primary school mathematics teachers’ awareness on mathematical modelling] *Adıyaman University Journal of Social Sciences*, 12, 1-34. <https://doi.org/10.14520/adyusbd.410>
- Altun, M. (2018). *Ortaokullarda matematik öğretimi [Teaching mathematics in secondary schools]*. (13. Ed.). Aktüel Alfa Akademi Publishing.
- Aydın Güç, F. (2015). *Matematiksel modelleme yeterliklerinin geliştirilmesine yönelik tasarlanan öğrenme ortamlarında öğretmen adaylarının matematiksel modelleme yeterliklerinin değerlendirilmesi[Examining mathematical modeling competencies of teacher candidates in learning environments designed to improve mathematical*

- modeling competencies*]. [Unpublished doctoral thesis]. Karadeniz Technical University, Trabzon.
- Borromeo Ferri, R. (2006). Theoretical and empirical differentiations of phases in the modelling process. *Zentralblatt für Didaktik der Mathematik (ZDM)*, 38 (2), 86-95. doi.org/10.1007/BF02655883
- Bilen, N., & Çiltaş, A. (2015). Ortaokul matematik dersi beşinci sınıf öğretim programının öğretmen görüşlerine göre matematiksel model ve modelleme açısından incelemesi [Evaluation of mathematical models and modeling in the fifth-grade mathematics curriculum based on teachers' views] *Kafkas University, e-Kafkas Journal of Educational Research*, 2(2).
- Bukova Güzel, E. (2016). *Matematik Eğitiminde Matematiksel Modelleme*[*Mathematical Modeling in Mathematics Education*]. (1. Ed.). Pegem Akademi Publishing.
- Chacko, I. (2004). Solution of real-world and standard problems by primary and secondary school students: A Zimbabwean example. *African Journal of Research in SMT Education*, 8 (2), 91-103 <https://doi.org/10.1080/10288457.2004.10740564>.
- Deniz, D., & Akgün, L. (2014). Ortaöğretim öğrencilerinin matematiksel modelleme yönteminin sınıf içi uygulamalarına yönelik görüşleri [Secondary school students' views on the classroom practices of mathematical modelling method]. *Trakya University Journal of Education*, 4(1), 103-116.
- Deniz, D. & Akgün, L. (2016). The sufficiency of high school mathematics teachers' to design activities appropriate to model eliciting activities design principles. *Karaelmas Journal of Educational Sciences*, 4, 1-14. <https://www.researchgate.net/publication/321723265>
- Doruk, B. K. (2010). *Matematiği günlük yaşama transfer etmede matematiksel modellemenin etkisi* [The effects of mathematical modeling on transferring mathematics into daily life]. [Unpublished doctoral thesis]. Hacettepe University, Ankara.
- English, L. D., & Watters, J. J. (2005) Mathematical modeling in the early school years. *Mathematics Education Research Journal*, 16(3), 59-80. <https://www.researchgate.net/publication/43075244>
- Eraslan, A. (2011). İlköğretim matematik öğretmen adaylarının model oluşturma etkinlikleri ve bunların matematik öğrenimine etkisi hakkındaki görüşleri [Prospective elementary mathematics teachers' perceptions on model eliciting activities and their effects on mathematics learning]. *Elementary Education Online*, 10(1), 364-377.

- Erbaş, A.K., Çetinkaya, B., Alacacı, C., Çakıroğlu, E., Aydoğan-Yenmez, A., Şen-Zeytun, A., Korkmaz, H., Kertil, M., Didiş, M.G., Baş, S. & Şahin, Z. (2016) *Lise Matematik Konuları için Günlük Hayattan Modelleme Soruları*. Ses Reklam Matbaacılık
- Greer, B. (1993). The mathematical modeling perspective on world problems. *Journal of Mathematical Behavior*, 12(2), 239–250
- Güder, Y. (2013). *Ortaokul matematik öğretmenlerinin matematiksel modellemeye ilişkin görüşleri [Opinions of secondary school mathematics teachers on mathematical modelling]*. [Unpublished master's thesis]. Fırat University, Elazığ.
- Güler, A., Halıcioğlu, M.B., & Taşgın, S. (2015). *Sosyal bilimlerde nitel araştırma [Qualitative research in social sciences]*. (2. Ed.). Seçkin Publishing.
- Işık, A., & Mercan, E. (2015). Ortaokul matematik öğretmenlerinin model ve modelleme hakkındaki görüşlerinin incelenmesi [Analysis of the views of secondary school maths teachers on model and modeling]. *Kastamonu Educational Journal*, 23(4), 1835-1850.
- İncikabı, S. (2020). *Matematiksel modelleme etkinliklerinin ilköğretim matematik öğretmen adaylarının matematiksel modelleme yeterliklerine ve öğretim deneyimlerine yansımalarının araştırılması [Investigation of reflections of mathematical modeling activities on the mathematical modeling efficacy and teaching experiences of prospective primary school mathematics teachers]*. [Unpublished doctoral thesis]. Kastamonu University, Kastamonu.
- Kaiser, G., & Brand, S. (2015). Modelling competencies: Past development ve further perspectives. In G. A. Stillman, W. Blum ve M. S. Biembengut (Eds.), *Mathematical modelling in education research ve practice* (pp. 129–149). Springer International Publishing
- Kang, O., & Noh, J. (2012, July). Teaching mathematical modelling in school mathematics. In 12th International Congress on Mathematical Education (8-15). Seoul, Korea.
- Karalı, D. (2013). *İlköğretim matematik öğretmen adaylarının matematiksel modelleme hakkındaki görüşlerinin ortaya çıkarılması [Revealing the thoughts of the secondary school mathematics pre-service teachers on mathematical modelling]*. [Unpublished master's thesis]. Abant İzzet Baysal University, Bolu
- Kertil, M. (2008). *Matematik öğretmen adaylarının problem çözme becerilerinin modelleme sürecinde incelenmesi [Investigating problem solving ability of pre-service mathematics teachers in modeling process]*. [Unpublished doctoral thesis]. Marmara University, İstanbul

- Lesh, R. A., & Doerr, H. (2003). Foundations of a models and modeling perspective on mathematics teaching and learning. In R. A. Lesh, ve H. Doerr (Eds.), *Beyond constructivism: A models and modeling perspective on mathematics teaching, learning, and problem solving* (pp. 3-34). Mahwah, NJ: Lawrence Erlbaum
- Maaß, K. (2006). What are modelling competencies? *The International Journal on Mathematics Education*, 38 (2), 113-142
- MEB, (2009). İlköğretim Matematik dersi 1-5. sınıflar öğretim programı. Talim ve Terbiye Kurulu Başkanlığı.
<http://talimterbiye.mebnet.net/Ogretim%20Programlari/ilkokul/2013-2014/Matematik1-5.pdf>
- MEB, (2015). İlkokul matematik dersi öğretim programı (1, 2, 3 ve 4. sınıflar). MEB
http://matematikogretimi.weebly.com/uploads/2/6/5/4/26548246/matematik1-4_prg.pdf
- MEB, (2018). İlkokul matematik dersi öğretim programı (ilkokul ve ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. sınıflar). Ankara: MEB <https://mufredat.meb.gov.tr/Dosyalar/201813017165445-MATEMAT%C4%B0K%20%C3%96%C4%9ERET%C4%B0M%20PROGRAMI%202018v.pdf>
- MEB, (2020). Ölçme, Değerlendirme ve Sınav Hizmetleri Genel Müdürlüğü.
<https://odsgm.meb.gov.tr/www/timss-2019-turkiye-raporu-aciklandi/icerik/613>
- Miles, H. B. & Huberman, A.M. (1994). *Qualitative Data Analysis*. (2. Ed.), Thousand Oaks, CA: Sage.
- National Council of Teachers of Mathematics [NCTM], (2000). Principles vestandards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.
- OECD, (2019). PISA 2018 Assessment and Analytical Framework, PISA, OECD Publishing: Paris.
<http://www.oecd.org/education/pisa-2018-assessment-and-analytical-framework-b25efab8-en.htm>
- Ören Vural, D., Çetinkaya, B., Erbaş, A. K., Alacacı, C., & Çakıroğlu, E. (2013). Lise matematik öğretmenlerinin modelleme ve modellemenin matematik öğretiminde kullanılmasına yönelik düşünceleri: Bir hizmet içi eğitim programının etkisi. 1st International Symposium of Turkish Computer and Mathematics Education (TURCOMAT-1), Trabzon.
- Özdemir, E., & Üzel, D. (2012). Student opinions on teaching based on mathematical modelling. *Procedia-Social and Behavioral Sciences*, 55, 1207-1214.
<https://doi.org/10.1016/j.sbspro.2012.09.616>

- Pilten, P., Serin, M. K. & Işık, N. (2016). Sınıf öğretmenlerinin matematiksel modellemeye ilişkin algılarını belirlemeye yönelik bir olgubilim çalışması[A phenomenological study on classroom teachers' perceptions about mathematical modeling]. *Electronic Turkish Studies*, 11(3), 1919-1934. <http://dx.doi.org/10.7827>
- Soon, T. L., & Cheng, A. K. (2013). Pre-service secondary school teachers' knowledge in mathematical modelling. In G. A. Stillman, G. Kaiser, W. Blum, and J. P. Brown (Eds.). *Teaching mathematical modelling: Connecting to research and practice* (pp. 373–383). Springer
- Steffe, L. P. (1991). The constructivist teaching experiment: Implication and illustrations. E. von Glasersfeld (Ed.), *Radical constructivism in mathematics education* in (pp. 177–194). Dordercht, Kluver.
- Steffe, L. P. & Thompson, P. W. (2000). Teaching experiment methodology: Underlying principles and essential elements. R. Lesh and A. E. Kelly (Eds.). *Handbook of research design in mathematics and science education* in (pp. 267– 307). Hillsdale, Lawrence Erlbaum.
- Şahin, N. (2019). *İlkokul 4. sınıf öğrencilerinin bilişsel modelleme yeterliklerinin belirlenmesi ve değerlendirilmesi*[Determining and evaluating of primary 4th-grade school students' cognitive modelling competencies]. [Unpublished doctoral thesis]. Ondokuz Mayıs University, Samsun.
- Şahin, N., & Eraslan, A. (2019). Ortaokul matematik öğretmeni adaylarının matematik uygulamaları dersinde modelleme etkinliklerinin kullanılmasına yönelik görüşleri[Middle-school prospective mathematics teachers' opinions on the use of modeling activities at the course of mathematics applications]. *Turkish Journal of Computer and Mathematics Education*, 10(2), 373-393. <https://doi.org/10.16949/turkbilmate.434641>
- Tekin, A., Hıdıroğlu, Ç., & Bukova Güzel, E. (2011). Examining of model eliciting activities developed by prospective mathematics teachers. In *Proceedings of the 35th Conference of the International Group for the Psychology of Mathematics Education* (pp. 10-15).
- Tekin Dede, A. & Bukova Güzel, E. (2013). Ortaöğretim matematik öğretmenlerinin model oluşturma etkinlikleri ve matematik derslerinde kullanımlarına ilişkin görüşleri[Mathematics teachers' views concerning model eliciting activities, developmental process and the activities themselves]. *Bartın University Journal of Faculty of Education* 2(1), 300 – 322.

- Tekin, A., Kula, S., Hıdıroğlu, Ç. N., Bukova Güzel, E. & Uğurel, I. (2014). Determining the Views of Mathematics Student Teachers Related to Mathematical Modelling. *International Journal for Mathematics Teaching ve Learning*.
- Tekin Dede, A. (2015). *Matematik derslerinde öğrencilerin modelleme yeterliklerinin geliştirilmesi: bir eylem araştırması*[Developing students' modelling competencies in mathematics lessons: An action research study]. [Unpublished doctoral thesis]. Dokuz Eylül University, İzmir.
- Thomas, K., & Hart, J. (2010). Pre-service teacher perceptions of model eliciting activities. In R. Lesh et al. (Eds.), *Modeling students' mathematical modeling competencies* (pp. 531-539). Springer Science and Business Media
- Tutak, T., & Güder, Y. (2014). Opinions of secondary school mathematics school teachers on mathematical modelling. *Educational Research and Reviews*, 9(19), 799-806.
doi: 10.5897/ERR2014.1765
- Uğurel, I., Bukova Güzel, E., & Kula, S. (2011). Matematik öğretmenlerinin öğrenme etkinlikleri hakkındaki görüş ve deneyimleri [Mathematics teachers opinions and experinces related to learning activities]. *Buca Faculty of Education Journal*, 28, 103-123. <http://hdl.handle.net/20.500.12397/115>
- Urhan, S. & Dost, Ş. (2016). Matematiksel modelleme etkinliklerinin derslerde kullanımı: Öğretmen görüşleri[The use of mathematical modelling activities in courses: Teacher Perspectives]. *Elektronik Journal of Social Sciences* , 15(59), 1279-1295. <https://doi.org/10.17755/esosder.263231>
- Yıldırım, A. & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences] (9. Ed.). Seçkin Publishing

Appendices

Appendix 1.

HAVA DURUMU

Yurt dışına turlar düzenleyen bir seyahat şirketi tatile çıkacak müşterilerine gidecekleri yerin seçiminde danışmanlık yapmaktadır. Seyahate çıkacak olan müşteriler ilk olarak o yerin iklimi ile ilgilenip; ne kadar yağmur yağdığına, bir yılda havanın kaç gün güneşli yada kapalı olduğuna ve ne kadar sıcak yada soğuk olduğuna önem vermektedirler. Bu faktörlerin her biri seyahate çıkacaklar için farklı öneme sahiptir.

İki müşteri şirkete mail yollayarak tatil için istedikleri şehrin özelliklerini belirtmişler ve en uygun şehirleri tavsiye etmelerini istemişlerdir. Seyahat şirketi müşterilerine gitmeleri için dokuz şehir belirlemiş ve bu şehirlerle ilgili iklimiyle ilgili bazı bilgiler toplamıştır. Bu bilgiler ve müşterilerin mailleri aşağıda verilmiştir.

<p><i>Sayın Seyahat Şirketi Yetkilisi;</i> <i>Eşim ve ben geçen ay emekli olduk. Sıcak ve güneşli bir şehirde tatil yapmayı planlıyoruz. Çok soğuk bir şehir olmasın ama yağmurun yağmasını önemsemiyoruz. Eşim ve benim için uygun şehirler hangileridir önerilerinizi bekliyoruz.</i> <i>Meral Fatih BULUT...</i></p>	<p><i>Sayın Seyahat Şirketi Yetkilisi;</i> <i>Bir markette yönetici olarak çalışmaktayım. Bu yaz tatil için gideceğim yerde açık havada yapılabilecek her türlü sporu özellikle doğa yürüyüşünü denemek istiyorum. Çok sıcak olmayan ve aynı zamanda havası iyi olan bir şehirde tatil yapmak istiyorum. Hangi şehirleri önerirsiniz? Selamlar...</i> <i>Ahmet DEMİR...</i></p>
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Sizin Göreviniz:

- 1- Tatile çıkacak kişilerin isteklerine göre dokuz şehri karşılaştırmak için model (derecelendirme sistemi) geliştiriniz. Geliştireceğiniz bu model sadece bu dokuz şehir için değil başka şehirleri karşılaştırmak için de kullanılmalıdır.
- 2- Her iki tatilci için şirkete tavsiye mektubu yazınız. Bu mektupta önerdiğiniz şehirleri “en uygun şehirler”, “uygun şehirler” ve “uygun olmayan şehirler” olarak ayırmalısınız. Bu sayede tatilciler hangi şehirleri dikkate alması gerektiğini ve hangilerini dikkate almamaları gerektiğini bileceklerdir.
- 3- Mektuplarınızda puanlama sisteminizin nasıl çalıştığını ve neden oluşturduğunuz sistemin iyi sistem olduğunu seyahat şirketine açıklamalısınız.

ŞEHİRLER	GÜNEŞLİ GÜN SAYISI	15°C'NİN ALTINDAKİ GÜN SAYISI	30°C'NİN ÜSTÜNDEKİ GÜN SAYISI	YILLIK ORTALAMA YAĞIŞ(MM/YIL)
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LONDRA	85	12	15	1220
MADRİD	195	40	169	274
BERLİN	36	184	6	516
ATİNA	71	0	185	2222
PRAG	45	55	30	661
MİLANO	85	0	328	1534
ROMA	178	4	237	386
VİYANA	84	157	36	633
PARİS	114	10	58	863

Appendix 2.

KİM KOŞSUN

Anadolu Atletizm Kulübü bu yıl düzenlenecek olan 4000 m. koşu yarışmasına sporcu seçecektir. Bunu için öğrencilerin performanslarını belirlemeye yönelik bir çalışma yapılmıştır. Takımın antrenörü Sercan Hoca 4 gün süresince biri öğleden önce diğeri öğleden sonra olmak üzere 8 kez öğrencilerin 4000 metreyi kaç dakikada koştuklarını ölçmüştür. Sercan Hoca ve takımın diğeri antrenörü Atakan Hoca 4000 metre yarışına hangi sporcunun katılması gerektiği konusunda anlaşamamışlardır.

Aşağıda sporcuların 4000 metreyi kaç dakika ve saniyede koştuklarını belirten tablo bulunmaktadır.

Sizce hangi sporcu yarışmaya katılmalıdır? Kulübümüz için en uygun sporcuyu nasıl seçtiğinizi Atakan ve Sercan Hoca'ya bir mektup yazarak açıklayınız.

	BADE	TALYA	DAMLA	AYBÜKE
1.TUR	34' 25 "	36' 50 "	37' 40"	34' 40"
2.TUR	37' 45 "	34' 40 "	36' 40"	38' 50"
3.TUR	36' 20 "	36' 10 "	37' 50"	34' 40"
4.TUR	35' 55 "	35' 15 "	34' 50"	39' 40"
5.TUR	36' 40 "	35' 10 "	34' 50"	34' 20"
6.TUR	35' 55 "	36' 30"	36' 30"	35' 50"
7.TUR	37' 55 "	34' 50"	37' 50"	38' 20"
8.TUR	38' 50 "	36' 40"	35' 40"	34' 40"



Appendix 3.

ÇİFTÇİ HÜSEYİN AMCA

Çiftçi Hüseyin Amca'nın zeytin fidanı dikmeyi düşündüğü bir tarlası vardır. Eni boyunun iki katı uzunluğunda olan bu tarlanın alanı 5000 metrekaredir. Hüseyin Amca tarlasına en fazla sayıda zeytin dikmek istemektedir. Ancak zeytin bitkisinin gelişimi ve verimi göz önünde bulundurulduğunda zeytinleri belli aralarla dikmesi gerekmektedir.

İlçe Tarım Müdürlüğüne giden Hüseyin Amca şu bilgileri almıştır.

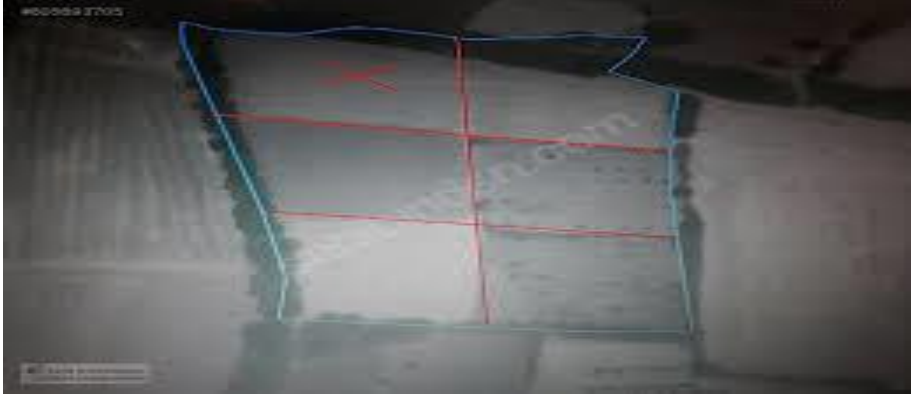
- Yüksek verim elde etmek için zeytin fidanları birbirlerine mesafeli dikilmelidir.

- Yetişkin bir zeytinin kökleri kazık şeklinde değil saçak şeklinde ilerlemektedir. Bu kökler 2-5 metreye kadar ilerlemektedir.

- Ağaçların taç (yaprığın gövde uzunlukları) uzunlukları saçak kök kadar olmaktadır.

- Verimli ağaçlarımız olsun istiyorsak; tarlamız yılda iki kez traktörle sürülmelidir.

Bu bilgiler doğrultusunda Hüseyin Amca'ya tarlasına kaç zeytin fidanı dikmesi gerektiği ve bu fidanların kaç metre arayla dikilmesinin uygun olacağı konusunda tarlanın kuş bakışı görünümünü çizerek yardımcı olunuz. Yapacağınız yardımı Hüseyin Amca'ya bir mektup yazarak açıklayınız.



Appendix 4. Başarı Değerlendirme Formu

1- Aşağıdaki sayıların rakamla yazılışlarını ve okunuşlarını yazınız

a- Kırk sekiz bin yüz dokuz:.....

b- 8008:.....

2-“1078” sayısını çözümleniz, en yakın onluğa ve yüzlüğe yuvarlayınız

Çözümleme:.....

En yakın onluk:.....

En yakın yüzlük:.....

3- “780201” sayısının onlar basamağı ile on binler basamağı yer değiştirdiğinde yeni sayı kaç olur?

Yeni sayı:

4-Aşağıdaki işlemleri yapınız. Verilmeyenleri bulunuz.

$$\begin{array}{r} 25467 \\ +74895 \\ \hline \end{array} \quad \begin{array}{r} 59634 \\ \boxed{} \\ \hline 76013 \end{array} \quad \begin{array}{r} 9A3B \\ +C8D6 \\ \hline 14302 \end{array}$$

5-Ardışık beş doğal sayıdan ortanca olan 47 olduğuna göre bu sayıların toplamı kaçtır?

6- 242 eksiği 505 olan sayının 57 fazlası kaçtır?

7-Bade ile kardeşi Cemre arasında 5 yaş fark vardır. Bade 2009 doğumlu olduğuna göre cumhuriyetimizin 100. yılında ikisinin yaşları toplamı kaç olur?

8- 2965 ceviz, 5784 ceviz, sepet ve toplamak ifadelerini kullanarak bir problem yazınız.

Problemim:.....
.....

9- Aşağıdaki işlemleri yapınız.

$$\begin{array}{r} 960284 \\ -782317 \\ \hline \end{array} \quad \begin{array}{r} 65420 \\ - \square \\ \hline 8347 \end{array} \quad \begin{array}{r} 7A43B \\ -39CD8 \\ \hline \end{array}$$

10-“78638 – 54947>” ifadesinde noktalı yere yazılabilecek en büyük doğal sayı kaçtır?

11-Tüm rakamları aynı olan dört basamaklı en büyük çift sayıya hangi sayıyı eklersek toplam 15723 sayısı olur?

12-Aşağıdaki işlemleri yapınız?

$$\begin{array}{r} 54 \\ \times 38 \\ \hline \end{array} \quad \begin{array}{r} 769 \\ \times 37 \\ \hline \end{array} \quad 825 \times \square = 13925$$

$$47 \times 65 \times 29 = 65 \times 29 \times \square$$

Ek 4. (Devam) Başarı Değerlendirme Formu

13- “24,35,5 arkadaş, kilo ve şeker” ifadelerini kullanarak çarpma işlemi gerektiren bir problem oluşturunuz.

Problemim:.....
.....?

14- Fazıl SAY’ın Konya’da vereceği konsere, 37 koltuk bulunan 24 sıra ve 48 koltuk bulunan 127 sıra bulunmaktadır. 6400 bilet satıldığına göre konseri kaç kişi ayakta izleyecektir?

15-Aşağıdaki bölme işlemlerini yapınız. Verilmeyenleri bulunuz.

$$\begin{array}{r} 84 \overline{) 4} \\ \hline \end{array} \quad \begin{array}{r} 378 \overline{) 16} \\ \hline \end{array}$$

$$6A6 \div 38 = 17 \quad 4128 \div \square = 96$$

16- Aşağıdaki işlemlerdeki bölümün kaç basamaklı olduğunu işlem yapmadan tahmin ediniz.

$$\begin{array}{r} 75 \overline{) 6} \\ \hline \end{array} \quad \begin{array}{r} 87 \overline{) 9} \\ \hline \end{array} \quad \begin{array}{r} 576 \overline{) 6} \\ \hline \end{array}$$

...basamaklı ... basamaklı ...basamaklı

17- Ali, 597 sayfa olan kitabı dokuz günde okumaktadır. İlk gün 64 sayfa, ikinci gün 78 sayfa okumuştur. Kalan günlerde eşit sayıda sayfa okudu. Ali kalan günlerde kaç sayfa kitap okumuştur?

18-“450, 18, öğrenci ve otobüs” ifadelerini kullanarak bölme işlemi gerektiren bir problem kurunuz.

Problemim:.....
.....?

13 ve 18. Sorular 10 puan diğer sorular 5puandır...

BAŞARILAR 😊😊