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SIMILARITY AND DIFFERENCES IN VISUALS IN MATHEMATICAL MODELING OF PRIMARY AND SECONDARY MATHEMATICS TEACHERS[1]

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ABSTRACT

In today's mathematics curriculum, it is clearly stated that "people who can use in the problem solving process, apply to different disciplines, make assumptions, make generalizations, think analytically, model problems with mathematical reasoning, relate models with verbal and mathematical expressions". In this context, it is important that mathematics teachers, who are practitioners of the curriculum, use mathematical modeling practices in their lessons and put them into mathematical modeling. The purpose of this research is to determine the opinions of mathematics teachers of primary and secondary schools about the mathematical modeling. This study, which used phenomenological design, was conducted with the participation of four primary and four secondary school mathematics teachers in Erzurum province center. The data of this study with a total of eight teachers were collected with semi-structured interviews and analyzed descriptively. While each primary school mathematics teacher who participated in the interview applied mathematical modeling, it was determined that none of the secondary mathematics teachers practiced it. At the end of the study, teachers at both levels did not have enough knowledge about mathematical modeling and teachers were not aware of it. For this reason, it is considered useful to add a curriculum for mathematical modeling in teacher training institutions.

Keywords: Mathematical modeling, primary school mathematics teachers, secondary school mathematics teachers.

[1] This study was presented as summary at ISOEVA 2017.

INTRODUCTION

According to Baki and Mumcu (2017) it is important to raise generations who know the real and living aspect of mathematics and use mathematics efficiently in their daily lives by finding efficient solutions to real problems they may face in real life, know mathematics and use it efficiently when applicable, find functional solutions to the problems they would face by using their mathematical knowledge and skills, make the most suitable selections and create necessary combinations whenever they need to make a decision by taking all conditions into consideration and thus, make life easier for themselves. In order for individuals to use mathematics in their daily life today, they need to have mathematical knowledge and basic skills to be able to use this knowledge by associating it with real-life situations. Accordingly, numerous questions and issues related to learning and teaching mathematics and approaches, methods and techniques that have affected the relationship of mathematics with the real world and would facilitate the transfer of mathematics to daily life have gained importance. Visualization in mathematics is largely actualized by models(Toptaş, Han and Akın, 2017). The concept of a model is defined by Olkun and Toptaş (2007) as "real objects, drawings or symbols used to demonstrate mathematical concepts or relationships". Mathematical modeling is one of these methods and its importance has been increasing rapidly in recent years. As a matter of fact, when the new elementary and secondary education mathematics curriculum is examined, the fact that mathematical modeling is included in the basic skills supports this consideration.

In a general sense, mathematical modeling, which was included in mathematics curriculum after they were changed in 2005 is a cyclical process of finding mathematical solutions by converting a real-life problem into a mathematical one and interpreting these mathematical solutions in real context. Therefore, mathematical modeling is presented as a regular and dynamic method that reduces the gap between mathematics and real life (Ortiz and Dos Santos, 2011). Thus, it is seen that mathematics is not unrelated to daily life, and mathematics is not only composed of rules and procedures of the language of mathematics. So students' tendency to see mathematics as a discipline isolated from real life was eliminated through the use of mathematical modeling, and they are made to recognize that the mentality which finds solutions to real-life problems by way of modeling is actually one of the dimensions of mathematics (MEB, 2009a).

Mathematical modeling is one of the most important methods that enable the students to use their capacity to determine and understand the role of mathematics in the world, to functionally use their knowledge of mathematics under numerous circumstances and in contents. It is seen that studies that include mathematical modeling found in international literature become popular in Turkey recently. When these studies are examined, it is seen that they are generally focused on the modeling process (Eraslan, 2012; Tekin Dede and Bukova Guzel, 2013b; Ural, 2014), development of modeling skills (Bal and Doganay, 2014) and modeling competencies (Tekin Dede and Yilmaz, 2013; Karabas, 2016). There are also many studies on views of mathematical modeling are in the literature (Çiltaş and Bilgili, 2016; Deniz and Akgün, 2014; Eraslan, 2011; Özdemir and Işık, 2015; Tekin Dede and Bukova Güzel, 2013; Yanık, Baghdad and Koparan, 2017). When these studies are examined it is seen that

both teachers and prospective teachers have extremely limited knowledge and experience on mathematical modeling before study and modeling problems, and their opinions are changed in a positive manner after their training about the applied mathematical modeling.

Çiltaş and Bilgili (2016) have conducted an action research to improve the mathematical modeling skills of prospective teachers and determined the increase in the success of prospective teachers at the end of the training of applied mathematical modeling. Deniz and Akgün (2014) have received the opinions of secondary education students about the implementation of mathematical modeling method in the class and included more apprehensible, interesting and thought-provoking statements of students with regard to mathematical modeling. Eraslan (2011), who included the opinions of primary education prospective mathematics teachers about model building activities and their effects on the mathematical study, has stated that prospective teachers regard the mathematical modeling as a process that requires high level thinking skill. In their study on the opinions of teachers about teaching the areas and volumes of solids with mathematical modeling method, Ozdemir and Isik (2015) have revealed that teachers don't have enough knowledge about mathematical modeling. In their study on design processes of model building activity, Tekin Dede and Bukova Guzel (2013b) have received the opinions of teachers and stated that the teachers have positive opinions regarding mathematical modeling. Yanık, Bağdat and Koparan (2017) have examined the opinions of prospective secondary education teachers on mathematical modeling problems and stated that the prospective teachers find the implementation of mathematical modeling difficult due to the problems such as time management and classroom management, but they believe it would help students to gain many mathematical thinking skills if implemented.

When the conducted studies are examined, it is seen that they address the awareness of mathematics instructors and teachers on modeling, how they use modeling, their experiences in the mathematical modeling process, and their troubles and conveniences. In consideration of the studies, it is seen that there are not many studies conducted on awareness of primary and secondary education mathematics teachers of mathematical modeling. If mathematics teachers do not have sufficient knowledge of mathematical modeling or could not develop their mathematical modeling skills sufficiently, both teachers and students may experience significant difficulties in this process. Whereas, being informed of the awareness and opinions of primary and secondary education mathematics teachers about mathematical modeling will increase the quality of the approach to the teaching process. For this reason, this study seeks answers to the following problems:

- What are the opinions of primary education mathematics teachers about mathematical modeling?
- What are the opinions of secondary education mathematics teachers about mathematical modeling?
- What are the similarities and differences between the opinions of primary and secondary education mathematics teachers about mathematical modeling?

METHOD

Research Design

The phenomenology design, one of the qualitative research methods is used in this study. This design aims at revealing the experiences and perceptions of individuals related to a phenomenon and the meanings they ascribe to them. The sample in this method is composed of a relatively small number of individuals and data collection tools are interviews and observations. It doesn't aim to reveal generalizable solutions. Data sources in phenomenology researches are individuals or groups who have experienced the phenomenon that the research is focused on and express or reflect this phenomenon (Yıldırım and Şimşek, 2016). In studies where phenomenology design is used, the individuals from whom the data are obtained are those who have personally experienced this phenomenon and are able to express or reflect it. Therefore, teachers who have personally experienced mathematical modeling and able to use it in their classrooms are chosen in this study. In this study it is aimed to determine the awareness of primary and secondary education mathematics teachers of mathematical modeling and whether they apply mathematical modeling in their lessons or not by using phenomenology design and by way of semi-structured interviews.

Respondents

The research group of this study is composed of four primary education mathematics teachers and four secondary education mathematics teachers. The numbers of female and male primary education mathematics teachers participated in the study are three and one respectively while they are two male and two female secondary education mathematics teachers. In compliance with codes of conduct, the teachers whose statements are included in the study are coded by the first letters of their names and surnames and their full names are not mentioned (e.g. SB for Sibel Bilgili)

Data Collection Tools and Data Analysis

Semi-structured interview forms are used as data collection tools in the research. The content of the interview form is prepared in parallel with the headings included in the findings section of the study. The studies conducted by Lingefjärd (2007), Keskin (2008) and Akgün, Çiltaş, Deniz, Çiftçi and Işık (2013) are used to prepare the interview questions. The interview questions are examined by two faculty members to ensure their validity and reliability. In addition, a pilot study is conducted with a primary education mathematics teacher to ensure validity and reliability of interview questions in terms of clarity. The interviews are aimed to determine the awareness of primary and secondary education mathematics teachers of mathematical modeling and whether they apply mathematical modeling in their lessons or not. In addition, it is tried to determine whether there is a difference between the opinions of two different teacher groups on mathematical modeling. Permission is obtained from teachers to record the interviews and all interviews are recorded with a tape recorder. The interview notes are put down on paper the same day. The interviews have lasted for 5-10 minutes. Descriptive analysis is used to

analyze the data obtained from the interviews made to determine the primary and secondary education mathematics teachers' awareness of mathematical modeling and the similarities and differences among them in respect of their perspectives of mathematical modeling. In the descriptive analysis, the data are summarized and interpreted according to the themes revealed by the research questions prepared in advance or made out through observations and interviews. The categories of analysis in this study are formed by using the content analysis used in the study conducted by Akgün, Çiltaş, Deniz, Çiftçi, Işık (2013). The data obtained from the interviews are put down on paper the same day and lists of categories and codes are created for these data. The data are classified under these categories and made meaningful for the reader. In order to increase the reliability of the study, the codes are examined by an expert other than the researcher and the percentage of compliance is found close to each other. In addition, the reliability of the study was ensured by making citations from the data obtained from the interviews. The categories, codes and frequencies of the codes obtained from the analysis of the data obtained from the interviews made with secondary education mathematics teachers are shown in Table-I while the categories, codes and the frequencies of the codes obtained from the analysis of the data obtained from the interviews made with primary education mathematics teachers are shown in Table-II.

FINDINGS

This section includes the findings related to the data obtained from the semi-structured interviews made with primary and secondary education mathematics teachers.

Findings Related to Primary Education Mathematics Teachers

Table-3. Category, Code and Frequency Table of Primary Education Mathematics Teachers

CATEGORIES	CODES	f
Model	Product/Shape	2
	Material	1
Modeling	Embodiment	3
	Example	2
Mathematical model	Mathematical shape	2
	Material	1
	Field of application	1
Mathematical modeling	Mathematical expression	2
	Example	1
	Field of application	1
Inclusion of mathematical modeling in curriculum	Useful	4
Problems encountered in the process	Crowded classrooms	2

	Lack of mathematical model	1
	Low student profile	1
	Inadequacy of textbooks	1
Topics suitable for mathematical modeling methods	Fractions	2
	Integers	1
	Probability	1
	Problems	2
	Factorization	1
	Geometry	2
Associating the objectives	with daily life	1
	Comprehensibility	1
	Conspicuousness	1
Opinions and advices	Improving the textbook	1
	Making performance homeworks	1

Teachers' Views on the Concept of "Model"

The answers of the teachers regarding the concept of a model are coded as "product/shape and material" under the category of "Model".

Ş.M., who considers the model as a product, shape stated that,

> *"...model means, well, when you face a problem, I mean a problem you face in daily life or mathematics, it means, well, the thing we find by way of modeling so that the student would make a sense of it, maybe embody an abstract expression. Right? It is the shape we use in modeling or obtain as a result.*

F.A.'s opinion who states that model is visual materials needed to make an incomprehensible situation comprehensible said:

> *"...I can define the model as the materials used to make something incomprehensible more understandable or visual examples."*

Teachers' Views on the Concept of "Modeling "

The codes of "embodiment and example" are reached from the statements of teachers whose opinions regarding modeling category are received.

The opinion of V.A., who considers modeling is both embodiment and example, said:

> *"… "The visual example I give, I mean embodiment..."*

Teachers' Views on the Concept of "Mathematical Model "

The codes of "mathematical shape, material and field of application" are reached from the statements of teachers whose opinions regarding mathematical model category are received.

V.A. who stated that the mathematical model is an expression with mathematical shapes said:

> *"Mathematical, as I said, expressing the topics with shapes as in mathematics, I mean showing them with drawings."*

F.A. who stated that the mathematical model is a material said:

> *"...make it comprehensible, well, I said the same thing again, anyway, I would like to emphasize this, well, especially the materials. Because the material is important to us. Because the child does not understand anything from verbal narration if he/she does not touch it. Therefore, you know smart boards are in use now, if we make it with slides, videos, flash videos, modeling would be good for us."*

R.H. who stated that mathematical model corresponds to mathematical language in daily life said:

> *"Well, I think mathematics is a language. I mean it corresponds to a language in daily life. The unknown is x for us. I think modeling is its field of application. For instance, when we teach the identities, modeling an identity equation with the area is modeling, well, it is its field of application. Modeling is the part where this language is applied."*

Teachers' Views on the Concept of "Mathematical Modeling "

The codes of "mathematical expression, example and field of application" are reached from the statements of teachers whose opinions regarding mathematical modeling category are received.

Ş.M. who considers mathematical modeling is lecturing with mathematical expressions said:

> *"I can say that the modeling we do in mathematical modeling is doing with mathematical expressions in the field of mathematics, or doing it by using mathematical materials."*

R.H. who considers mathematical modeling as a field of application said:

> *"When we talk about mathematical modeling, you know, each statement in daily life corresponds to something in mathematics, so all these knowledge we use in mathematics have fields of*

application. I call them mathematical modeling, that is I think of them as application areas where we use mathematics."

Teachers' Views on Including Mathematical Modeling in Curriculum

The answers of interviewed teachers regarding the inclusion of mathematical modeling in the curriculum are collected in the category of "Inclusion of Mathematical Modeling in Curriculum". The only code in this category is "useful". All interviewed teachers think that the inclusion of mathematical modeling in the curriculum will be useful. R.H.'s view in this respect is as follows:

"As mathematics is an abstract course, modeling will help the students to comprehend this course. Because they will understand it better. It will help them to envision it. This is why I find it useful to add it to the curriculum."

Teachers' Views on Problems They Face in Mathematical Modeling Process

The problems encountered in mathematical modeling process are coded based on the analysis of the teachers' opinions and these codes are named as "crowded classrooms, lack of a mathematical model, low student profile and insufficiency of textbooks". The statements made by the interviewed teachers reveal that teachers face with more than one problem and this is shown with frequencies in Table-II. V.A. who specified the problems faced as crowded classrooms and low student profile said:

"I am a teacher at a state school now and you know, some classrooms can be crowded and in some of them, I cannot find students with capacity. Like I said, sometimes I may cause that child to detract from the course."

Ş.M. who specifies the problems encountered in the process of applying mathematical modeling as insufficient content of textbooks which cannot guide the students as needed, said:

"... I don't like the textbooks given by the state much. I think they provide a limited number of examples in an attempt to bring modeling into the forefront. I think they have limited the curriculum. Somethings are missing. For example, there are more gains in test books, more questions, more varieties. But the textbooks are shallow."

Teachers' Opinions on Mathematical Topics where Using Mathematical Modeling is Suitable

The codes given in Table-II are formed by analyzing the opinions of teachers on "Topics where Using Mathematical Modeling Method is Suitable". These codes reveal that the topics which teachers consider using mathematical modeling method will be useful are "fractions and problems". F.A.'s opinion in this respect is as follows:

"Particularly fractions definitely require modeling. Topics in geometry also require it. Particularly the topic of expansion in geometry, like area expansion, calculation of areas, volumes, lengths. I mean, I think modeling will be useful in geometry. Of course, this sometimes requires us in cases of this problem. (Hiçbir şey anlayamadım ???) Yes, we can include problems in modeling."

Ş.M. who stated that the topic most suitable for mathematical modeling is integers and separating into factors said:

"I mean it is not suitable for all topics, I mean how you will adapt it but I mostly use it for integers, it really helps me. Because it is a challenging topic for me. Equations, separating into factors, well, what else, I cannot think of anything else now but I use it for integers at most."

R.H. who stated that the topic which is most suitable for mathematical modeling is probabilities, said:

" … "In its simplest form, I did this in probabilities. I mean it attracted girls' attention in the selection of a dress. Like how many combinations you can make. I mean, they said these are actually what they think and it has something to do with mathematics and they established the connection..."

Teachers' Views on Intended Use of Mathematical Modeling

The codes of "associating with daily life, comprehensibility and conspicuousness" are reached when the opinions of teachers on "Intended Use of Mathematical Modeling" category are received. F.A. who uses mathematical modeling for associating with daily life, said:

"We try to associate it with daily life for sure. I mean if we don't have any materials, we try to create materials in accordance with current circumstances or try to exemplify."

R.H. who stated that he/she uses mathematical modeling to make the topic understandable, said:

"I use it to make the topic more understandable. But my student profile is a bit away from mathematics. So it is important to attract their attention because they have to like mathematics first. Their mathematics background is not good enough. They are afraid of it. Using different things is more fun for them. When they are interested in, they ask themselves, "what is this", "why did the teacher use this" Then it is easier for them to envision."

V.A. who stated that he/she uses mathematical modeling to attract the attention of students when he/she lectures about a new topic, said:

"In order to attract their attention. To bring the students closer to the topic. I think it is more suitable then."

Opinions and Advices of Teachers

The codes of "improvement of textbooks and fulfillment of performance homeworks " are reached when the opinions and advices of teachers on "the implementation process of mathematical modeling" are received. V.A.'s opinion on this is as follows:

> *“Let me tell you this. As I said earlier, I mean if it is used for certain topics, I mean if they guide us in textbooks, that is modeling can be used this way or if they send us applicable models, I think it would be better."*

F.A. who stated that preparing a performance homework would increase the modeling capability of students, said:

> *"The children themselves, well, actually there was such a thing as performance homework at schools once. This can be. Because children comprehend such topics when they do homeworks. Bringing back the performance system might be good in this respect. Because sometimes children, I mean, they can make the case an explanation by modeling method like cut-and-paste." (???)*

The teachers, whose opinions of mathematical modeling are received have stated that necessary models and materials should be available for mathematical modeling to be used apart from the data given in the table of categories, codes and frequencies. Moreover, they have stated that individual interest is necessary for modeling to be applied in classrooms but even so, it cannot be applied in every lesson. However, all four primary education mathematics teachers have stated that they use mathematical modeling when necessary.

Findings Related to Secondary Education Mathematics Teachers

Table-4. Category, Code and Frequency Table of Secondary Education Mathematics Teachers

CATEGORIES	CODES	f
Model	Simple state	2
	Visualization	1
	Material	1
Modeling	Process of teaching with model	4
Mathematical model	Mathematical expression	3
	Simulation	2
Mathematical modeling	Process	3
Inclusion of mathematical modeling in curriculum	Useful	4
Problems encountered in the process	Time	3
	Lack of mathematical model	3

	Low student profile	2
	Insufficient teaching equipment	3
Topics suitable for mathematical modeling methods	Function	3
	Limit - Derivative	2
	Integral	1
	Problems	2
	Geometry	1
	Parabola	1
Intended uses of mathematical modeling	Enhancement	1
	Permanence	1
	Embodiment	1
Opinions and advices	In-service training	3
	Being an elective course	1

Teachers' Views on the Concept of "Model"

The answers of the teachers about the concept of the model are coded as "Simple state, visualization, material" under "Model" category.

U.Y. who defines "model" as the simpler state of something which has the same features of the original but not exactly the same, said:

> *"Model, well, I mean, how can I say, the model is showing something to others in a much simpler form. Yeah, I'd say so. I mean, drawing the picture of a human and of "Cin Ali". Simplifying something with simple symbols or objects."*

H.Ö. who stated that the model is visualization, said:

> *"I think the model is narrating any topic by using shapes, formulas or computer applications."*

The opinion of F.Y., who thinks that the model is a kind of miniature, is as follows:

> *"Model is the things apart from the information we use when we try to teach the information we want to convey. It can be a material, it can be a presentation, that is, everything we actually envisage in children's minds."*

Teachers' Views on the Concept of "Modeling "

All teachers have defined modeling as the "teaching process by way of models". F.Y. said:

> *"The process in which we use the model."*

Teachers' Views on the Concept of "Mathematical Model "

There are "mathematical expression and simulation" codes in this category. The opinion of F.Y. who considers it as a mathematical expression is as follows:

> *"If we do this within the scope of the course, it will be mathematical. If we use mathematical symbols and images, this is mathematical modeling for sure."*

The view of E.D., who considers the mathematical model as a simulation with mathematical expressions, is included in both mathematical expression and simulation code. His view is as follows:

> *"Mathematical, well, for instance, let me define the mathematical model. Well, we can actually say that. It is modeling or simulating any problem we face in daily life by using mathematical knowledge. I can define the mathematical model this way. Well, basically, it is problem-solving but when I say problem, I mean problems in real life. Benefiting from mathematical concepts, expressions when solving a real-life problem is a mathematical model."*

Teachers' Views on the Concept of "Mathematical Modeling "

Under this category, teachers' views expressed as "model building process and process of teaching with model" are coded under process code. E.D.'s views on this are as follows:

> *"Mathematical modeling, this well, all processes to build a model are modeling. I mean, specifying a problem, building an appropriate model for this problem and solving the problem by using this model is a process, mathematical modeling."*

Teachers' Views on Including Mathematical Modeling in Curriculum

The answers of interviewed teachers regarding the inclusion of mathematical modeling in the curriculum are collected in the category of "Inclusion of Mathematical Modeling in Curriculum". This category contains only the "useful" code. All teachers who participated in the interview consider inclusion of mathematical modeling in the curriculum is useful, positive. H.Ö.'s opinion in this respects is as follows:

> *"Mathematical modeling ensures the students approach mathematics from a different perspective. I think it's useful to add modeling to the curriculum."*

Teachers' Views on the Difficulties They Face in Mathematical Modeling Process

The problems encountered in mathematical modeling process are coded based on the analysis of the teachers' opinions and these codes are "time, lack of mathematical models, low student profile and insufficient teaching equipment". Basing on the statements of the interviewed teachers, it is recognized that a single teacher faces multiple problems and this is shown in Table-I with frequencies. E.D. whose problems are coded as time and low student profile stated his/her views as follows:

> *"We now a time constraint. There is a density of teaching programs. And the level of students is low. Modeling is a complex process. Students will have the knowledge, internalize and apply it. I mean this is the implementation phase of cognitive development phases. I mean, I don't think the students at my school are at that phase. We can only give information regarding, maybe the phase of comprehension. It requires some higher level skills and we have difficulty to implement it."*

Ü.Y. has stated that the problem he/she faces in the process of mathematical modeling is caused by insufficient teaching equipment and lack of accessible models. Ü.Y. said:

> *"Let me put it this way. We, as teachers don't have enough knowledge about it. I have never taken lessons in this regard during my undergraduate or postgraduate education. Education is insufficient. We did not learn anything about it during the in-service training. I mean, I cannot find any argument in modeling to which I can access, I mean a source that I can have access to and try to learn about the topic. Then you need to generate something by yourself, I mean you actually don't know its background and when you try to transfer the information, it becomes difficult. You can't tell because you're incompetent, you didn't receive a proper education and so, you cannot build a good mathematical model. I mean the best mathematical model we build is, well, identifying the functions with a factory. That's it. I cannot give further examples."*

Teachers' Opinions on Mathematical Topics where Using Mathematical Modeling is Suitable

Opinions of teachers on the category of "Topics Suitable for Using Mathematical Modeling Method" are analyzed and the codes given in Table-I are formed. Basing on these codes, it is seen that the topics that teachers consider most suitable to use mathematical modeling method are "functions, limits-derivatives and problems". F.Y.'s opinion on this is as follows:

> *"Like I said, it is used in functions, like the mother-child relationship. It helps the topic to be understood well. Or limits and derivatives can be visualized by using geogebra (?)"*

Opinions of E.D. who states that problems and functions are the most suitable topics for mathematical modeling, said:

"The most suitable topics for mathematical modeling are equations and inequalities. In the learning field, well, problems, real-life problems are suitable, too. It is also useful for functions. Particularly functional symmetries, algebraic properties of functions are suitable for modeling. It is especially useful for these two topics."

Teachers' Views on the Purpose of Using Mathematical Modeling

When the opinions of teachers for the category of "Purposes of Using Mathematical Modeling" are analyzed, the codes of "permanence, enhancement and embodiment" are reached. Opinions of H.Ö. who uses mathematical modeling for enhancement are as follows:

"I mean like this. It can be used at the beginning of the topic, well, in the middle and for enhancement after it is finished. I mean, students have different types of intelligence, I mean if one doesn't understand the topic whatever I do, I think it can be told better with modeling."

Ü.Y. who uses mathematical modeling for permanence, thinks as follows:

"I believe it is more permanent. Sure. It is more permanent for the student and I think I really address their spatial intelligence. Students are able to see and think in 3 dimensions. Actually, this is what we have been doing, all these complex symbols etc. serve to this purpose. I think these have been understood..."

The view of F.Y. who uses mathematical modeling for embodiment, thinks as follows:

"For transferring better. For embodying."

Opinions and Advices of Teachers

When the opinions and advices of teachers regarding the implementation process of mathematical modeling, the codes of "in-service training and elective course" are reached. As seen from the frequencies in Table-I, the majority of teachers consider in-service training necessary. E.D. said:

"Here, the teacher is important. If teachers don't know how to implement modeling, how to do it, then it is no use. If teachers receive in-service training, if they learn how to do modeling, in what way... This mathematical modeling becomes applicable..."

H.Ö. considers that mathematical modeling should be an elective course for groups who have learning difficulty. H.Ö. said;

"Apart from these, something like this may happen, mathematical modeling may be an elective course. You know, sometimes there are verbal classes. They take a basic mathematics course for 2 hours. In fact, the topics in basic mathematics course are really suitable for modeling. Maybe the

name of the course can be changed into mathematical modeling in those classes and as they are verbal students, something about modeling may be told. For example, this could be used in language classes. At least students' interest in mathematics my increase. When I hear of modeling, I also think of this. I think mathematics can also be used in daily life. This may be done."

Teachers whose opinions on mathematical modeling are received have stated that mathematical modeling method is not suitable for the current exam system apart from the data given in the table of categories, codes and frequencies. They have stated that "mathematical modeling necessitates more time and individual interest" to the contrary of the current exam system which is based on answering more questions in a shorter period of time. All four of the secondary education mathematics teachers stated that they don't use mathematical modeling in their lessons.

DISCUSSION AND CONCLUSION

In the interviews, primary education mathematics teachers defined mathematical modeling as a product, shape and material, while secondary education mathematics teachers defined it as simplification and visualization of an object and a material. These explanations reveal that teachers of both educations have explained the model similarly. Moreover, definitions of the model are in parallel with the argument of Van Driel ve Verloop (1999) who has suggested that a model should always be different from the target in certain ways.

Primary education mathematics teachers have defined modeling as embodiment of abstract concepts and visual examples and this shows parallelism with the argument of Çiltaş and Işık (2013) who state that mathematical concepts are abstract concepts by definition and modeling these concepts by using concrete examples will be useful to teach these concepts. Secondary education mathematics teachers have defined mathematical modeling as using models and this resembles the explanation of Kertil (2008) in his(her) study that modeling is the process of using models.

Primary and secondary education mathematics teachers have explained the mathematical model as mathematical shape, simulation and concrete material which show parallelism with the arguments of Cramer, Doerr, Post and Zawojewski (2003) as they complain that mathematical model is commonly considered only as a concrete material. However, a mathematical model reflects much more than a concrete material (Erbaş et al., 2014).

Primary education mathematics teachers have defined mathematical modeling as a mathematical expression, example and field of implementation of mathematical language in daily life. The opinion of only one teacher shows parallelism with the argument of Haines and Crouch (2007) who argue that mathematical modeling is a cyclical process in which the real-life problems are abstracted and converted into mathematical language, solved and tested. All primary education mathematics teachers have used the expression of "process" for mathematical modeling but only one of them has stated that it should be associated with daily life. This resembles the definition

of mathematical modeling by Blum and Feri (2009) who state that mathematical modeling is a process to overcome the problems in daily life.

In general, it is observed that primary and secondary education teachers don't have sufficient knowledge about the concepts of mathematical model and mathematical modeling. Because the majority of the interviewed teachers have emphasized that embodiment, visualization and material should be brought into the forefront for mathematical model and modeling. Whereas, naming the concrete materials used as teaching tools as models causes mathematical modeling to be perceived as limited with concrete material design and use. Whenas, mathematical modeling is used more comprehensively in mathematics education (Erbaş et al., 2014). The use of concrete materials does not reflect the scope of the general mathematical modeling phrase. In fact, these concrete materials are regarded as ready-made and static models of some mathematical concepts built by some people and it is criticized on the ground that it did not undergo individual's own structuring process according to modeling approaches based on structuring and socio-cultural learning theories (Gravemeijer, 2002).

All teachers have stated that the inclusion of mathematical modeling in the curriculum will be useful. The mathematical modeling skill included in secondary education mathematics curriculum earlier than primary education mathematics curriculum is not implemented by secondary education teachers. They have stated that this is caused by low student profile caused by insufficiency of basic education and intense curriculum. Nonetheless, all primary education mathematics teachers have stated that they use mathematical modeling in their lessons. However, each of the examples that teachers give in their lessons as mathematical modeling are mathematical models. These examples reveal that the teachers consider the mathematical model or using models as a mathematical modeling method.

When the opinions of primary education mathematics teachers regarding the problems they face in the mathematical modeling process are examined, they have stated that mathematical modeling requires individual interest but this is not possible in such crowded classrooms. In addition, they have stated that they consider mathematical modeling only as a material and consequently they experience lack of models, textbooks are not guiding in this context and student profile is not sufficient to gain mathematical modeling skills. They have also stated that mathematical models sometimes detract the students from the course instead of attracting their attention and complicate the lessons. Whereas, it is teachers' duty to form learning environments at schools to provide experiences to students related to mathematical modeling and develop their mathematical modeling skills to a great extent (Blum, 1991; Ji, 2012). The interviewed secondary education mathematics teachers have stated that they don't use mathematical modeling in their lessons because of the bad experiences they had. They have stated these experiences as; implementation of mathematical modeling requires more time but they have a heavy curriculum to complete; they have a deficiency of mathematical models; they don't have enough time to build a model for each lesson; the profile of the students is low due to insufficient basic education; and they don't have sufficient skills for mathematical modeling. These justifications show resemblance to the data in the study of Blum and Ferri (2009). Actually, it is considered that the teachers of both primary and secondary

education give justifications since they don't have the modeling competency a teacher should have stated by Blum and Kaiser (1997) in their study.

The interviewed primary education teachers have stated that they use mathematical modeling mostly for the topics of fractions, problems and geometry while the secondary education mathematics teachers find it suitable for functions, geometrical interpretation of limits-derivatives and problems. Topics of problems and geometry are common at both levels of education and mathematical modeling is considered most suitable for problems as stated by Verschaffel, Greer and De Corte (2002) because modeling is expressing the real-life situations and the relationships between them mathematically and a process of revealing mathematical patterns. When it comes to geometry, it is considered that there is a tendency caused by the mistake of approaching to mathematical model as a concrete and visual product.

Primary education mathematics teachers have stated that they use mathematical modeling to associate mathematics with daily life, make the course understandable and draw attention to the course. This approach was found to be in harmony with the gains in MEB Mathematics Course Curriculum (2013). Secondary education mathematics teachers, on the other hand, have stated that they use mathematical modeling to enhance the topic, ensure permanence and embody the mathematics course, which is abstract by nature. The objectives with regard to ensuring the permanence of and embodying the course support the objectives of mathematical modeling specified in the report by Blum (2002) that mathematical modeling makes the students comprehend mathematical concepts better and develop a positive attitude towards mathematics.

When other opinions and advices of teachers are examined, all primary education mathematics teachers consider that they implement mathematical modeling accurately but find textbooks insufficient, not guiding the teachers. They have also stated that performance homeworks should be included in the curriculum again. Secondary education teachers have stated that in-service seminars should be organized for them. Eraslan (2011) has emphasized in his(her) study that teachers should receive sufficient in-service training to be able to use mathematical modeling method. In addition, one of the teachers stated that mathematical modeling should not be considered as a skill but included in the curriculum as an elective course, and this can be implemented to embody the topics for groups of students having a learning difficulty and bring visualization to the forefront. This shows that the teacher is actually not competent for mathematical modeling.

SUGGESTIONS

Mathematical modeling skill is explicitly stated within the scope of general purposes in current curricula and the aim is ensuring all students to acquire it. However, this task is assigned to teachers in our country. However, the current problem is that the mathematical modeling competency of teachers is below the expected level. Whereas, teachers who have the knowledge of the mathematical model and mathematical modeling method and efficiently implement them in classrooms are needed for primary and secondary education students to be able to use mathematical modeling efficiently. Including mathematical modeling implementation courses in the

curricula of universities to enable teachers have the mathematical modeling approach will be useful to ensure the teachers acquire this skill. Teachers who are currently working can be introduced to mathematical modeling with in-service training seminars and thus, they can have the correct knowledge.

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