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Mathematical modelling research in Turkey: A content analysis study

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The aim of the present study was to examine the mathematical modelling studies done between 2004 and 2015 in Turkey and to reveal their tendencies. Forty nine studies were selected using purposeful sampling based on the term, "mathematical modelling" with Higher Education Academic Search Engine. They were analyzed with content analysis. Publication Classification Form (PCF) was used as data collection tool. The studies were evaluated based on publication year, research model, sampling method, sampling size, sampling group, data collection tools, number of data analyses methods and subject areas. Descriptive statistical calculations like frequency and percentages were used for data analysis and the findings are shown in tables. From the findings of this study, the followings were observed: the studies are generally qualitative research model, purposeful sampling method is prominently used as a data collection tool, university students were taken more in the sampling, the sampling size ranged from 1 to 30 and data analysis method was preferred more. Besides, "the effect of modelling method on modelling ability" variable is the area mostly treated in the subjects studied. In this research, applying mostly quantitative and combined research methods in mathematical modelling and using other student groups apart from university students as sample group in these studies are suggested.

Key words: Model, modelling, mathematical modelling, mathematical modelling process.

INTRODUCTION

To raise a generation that can access, interpret, process and use knowledge easily is the most important target of the education programs of any country because of its political, economic, and education benefits. For this purpose, educational institutions try to make individuals active in education by making them to understand and process knowledge. The future of a given people depends on their ability to access and use knowledge in today's world where technology and knowledge develop faster. One of the most important factors for adopting to the changes brought by science, technique and technology is being able to use the mind processes. It is a common knowledge that individuals who are able to use their mind processes effectively and creatively can get and give meaning to knowledge and thereby move their society forward more than their contemporaries.

Mathematics is a whole knowledge and technics which are formed of realities and abilities (Baki, 2014: 269). One way of being opened to developments and changes in technology and science is the ability to use

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mathematical technique and mind processes as well. A person who understands mathematics and uses it has more chances of shaping his or her future in this changing world. There is a necessity to use and understand mathematics. Mathematics and mathematics education with changes need to be reviewed and redefined in the direction of determined requirements (Ministry of National Education [MEB], 2009). Becoming skillful and sustaining it is possible by raising people who can use technology, are interdisciplinary, have the abilities to create model, and can solve problems not by memorizing knowledge but by processing (Thomas and Hart, 2010). MEB emphasized in Primary Education Mathematics Program (2009) that individuals who can use mathematics in daily life, solve problems, share solutions and thoughts, have self-confidence and positive attitudes must be raised. A way of up skilling is to benefit from the modelling and mathematical modelling.

Complicated model systems and structures are defined as a whole that is formed of conceptional structures in mind and external representations of these, while modelling is defined as the period served for problem matter model (Doruk, 2010). Models describe our beliefs about how the world functions. In mathematical modelling, we translate these beliefs into the language of mathematics (Lawson and Marion, 2008). Modelling in students' mathematics education is accepted as an important component. One of the important subjects of learning with mathematical model and education literature is the process of mathematical modelling because every mathematical model is an output of mathematical modelling process in principle (Kaiser et al., 2006). Mathematical model is to state the circumstances in real life as mathematical (Çiltaş and Yılmaz, 2013). Modelling is a multiple problem solving process such as reading and communicating, designing and applying problem solving strategies, or working mathematically (Niss, 2003). To choose a rational model in mathematics teaching will provide opportunity for students to think differently and create a series of meaning about the concept (Çiltaş and Yılmaz, 2013). Mathematical modelling helps students to use mathematical terms and apply them (Sokolowski, 2015). Mathematical modelling starts to gain much importance in students' mathematics education off late (Galbraith, 2012). Mathematical modelling is a dynamic method that makes it easier for us to see the relations in problems in every part of life, to state them with mathematics terms, to classify, generalize and draw conclusions (MEB, 2013: 4). It is defined as a mathematical process that comments on the model, has mathematical results like equality-equation and symbolic structures, approves mathematical analyses, estimates relations, and observes a fact. And there are benefits from many examples of real world that fit the mathematics own structure during these transactions (Lingefjärd, 2006).

According to the report of International Mathematics Teaching Commission, the purpose of mathematical modelling is to make students to understand mathematical concepts better, teach them to solve original problems, make them involve in critical and creative thinking and have a positive attitude towards mathematics (Blum, 2002). For most teachers, mathematical modeling represents a new way of "doing" mathematics that makes the addition of modeling activities into instruction seem daunting. This is especially true since modeling, when done properly, requires significant time and effort. In turn, some may be reluctant to include modeling activities into classroom time. It is essential to keep in mind that modeling is one of the eight Standards for Mathematical Practice given in the Common Core State Standards for Mathematics (CCSSM) for all grades and is a required conceptual category in high school. Because of this, modeling cannot be set aside or employed only during spare time. Class time that previously may have been spent using more traditional teaching methods should be converted to time spent on modeling. The integrated nature of mathematical modeling, and in turn, the number of curricular standards covered when working through a modeling activity, make modeling activities a very efficient use of class time (Chair et al., 2012).

Mathematical modelling concept is especially about International Student Consideration Program (PISA); it is the keystone of international researches that constitute the structure of mathematics. In the last decade, the awareness about mathematical modelling in Turkey increased and mathematics education researches started to center on mathematical modelling (Aztekin and Şener, 2015). In the studies on mathematical modeling and mathematical modelling in Turkey, the teacher candidates fail to satisfy in the mathematical modelling processes (Çiltaş and Yılmaz, 2013; Tuna et al., 2013). Research has shown that teachers do not apply the activities of mathematical modelling enough despite stating the necessity of using the mathematical modelling activities in education process (Dede and Güzel, 2013; Özdemir and Işık, 2015). Deniz and Akgün (2014) noted in the result of their study on mathematical modeling that the students adopted the mathematical modelling method and they converted their daily life problems to equation and formula. Tabak et al. (2010) extrapolated in their study that students have the ability to apply some modelling methods and are unable to apply others as well as the result of the modelling process; while Biber and Ulaş (2013) stated in their studies on modelling abilities of students in sets subject that most of them use modeling method to solve problems. When the researches in modelling area are evaluated, the study of English (2006) which was made with primary school children shows that students could create and improve their own mathematics processes, create reusable and generalizable systems by mathematical modelling method

in contrast to solving problem.

Mathematics is a part of life; sometimes a key, sometimes a game and entertainment for the “learner” that sees patterns, draws relationships, sees the reason behind what he/she has discovered, knows how to behave and makes decisions by himself/herself (Umay, 2007). Therefore, in mathematics instruction, the primary principles must be to make students realize the problem or requirement; make the students contemplate how to find a solution; and make them find the exit on his/her own if he/she can (Çiltaş and Işık, 2013). The aim of mathematics instruction is to inculcate in people mathematical knowledge and skills required for daily life; teach them how to solve problems; and make them think of how to deal with situations using problem solving approach (Altun, 2012).

Firstly, intangible information needs to be given meaning when looking at mathematics as a whole. In this respect, the importance of mathematical modeling is undeniable. Mathematical model is a pedagogic tool that provides the connection to school mathematics with an activity which is actually not a mathematics problem. It needs to be scrutinized if a sufficient level is reached or not by evaluating the researches from past till date for developing the modelling studies in mathematics education. Within this context, we can increase the use of modelling-based education in different class levels and obtain different information and perspectives about mathematical modeling in all studies evaluated in general terms in this research.

In the literature survey, there are few studies on the trends of the studies done in the field of mathematical modelling by the content analysis method. For this reason, it is necessary to examine the post-graduate theses and articles in mathematical modeling from the point of view of the general situation in the field. A study to be carried out in this context will re-analyze the various findings of the researches related to the previous subject to ensure that the hidden findings are revealed. Furthermore, this research will provide an insight to researchers in new postgraduate thesis, doctoral thesis and other studies about mathematical modeling. The main purpose of research with this information is to examine the scientific studies carried out in Turkey in the field of mathematical modeling between 2004 and 2015 and to determine their trends. In this respect, the answers to the following sub problems were searched:
Researches in mathematical modelling;

1. What is the distribution of the studies according to publication type and publication year?
2. What is the distribution of the studies according to research model?
3. What is the distribution of the studies according to sample selection method?
4. What is the distribution of the studies according to sample groups and sample sizes?
5. What is the distribution of the studies according to number of data collection tools used?
6. What is the distribution of the studies according to number of data analysis methods used?
7. What is the distribution of the studies according to subject fields?

METHODOLOGY

Research design

In this research, content analysis was preferred for examining the studies conducted regarding the mathematical modeling. Content analysis is a systematic, renewable technique in which some words of the articles could be summarized with smaller content categories and decoding based on rules (Büyüköztürk et al., 2006, p.250). This method is a research method in which some procedures are used for valid deduction of the text. These deductions are about the message sender, and the message itself of the intended population of the message. The rules of inferential process depend on the theoretic and basic profits of researcher (Weber, 1990). In this research, content analysis indicates the systematic analysis of mathematical modelling studies. This study provides a content analysis of the mathematical modelling studies, which are thesis and articles, obtained from Higher Education Institution (YÖK) academic database in Turkey.

Data collection tool

In the present study, the Publication Classification Form (PCF) developed by the researchers was used as a data collection tool. Related studies are coded based on PCF by differential features. This form comprising 11 parts are based on: publication type of studies, year released, data collection tools, sampling group and selection method, sampling size, data analysis method, used keywords, research method and affected subject areas. These parts are classified as the published studies, and then coding is done.

Review and selection criteria

To determine the studies to include in the present study, researcher used YÖK search engine with some advanced review and selection criteria such as selection of studies which the key words are found together in the title of study that was examined, searching in higher education search engine and publication year. Then, completed text papers and theses, published between 2004 and 2015 containing "mathematical modelling" and “modelling process in mathematics” words together in the title was searched. Then 29 articles and 29 theses (post graduate and doctoral thesis) that were published between these years were scanned. Seven thesis were excluded because they were rejected by writers, and two articles were excluded because they were not relevant to the research. Thereby, the research is limited to 49 studies: about 27 full text articles and 22 permitted theses (12 post graduate and 10 doctoral theses).

The purpose of content analysis is to reach concepts and relationships that can explain the collected data (Yıldırım and Şimşek, 2013, p. 228). In this context, the studies that are included in the scope of research are summarized in the table according to

Table 1. Distribution of studies according to publication year.

Year	Publication type				
	Article	Post Graduate	Doctorate	Total	Percentage
2004	1	0	0	1	2.0
2005	0	1	0	1	2.0
2007	0	1	0	1	2.0
2008	0	2	1	3	6.1
2009	1	0	0	1	2.0
2010	3	1	4	8	16.3
2011	4	1	2	7	14.3
2012	0	2	0	2	4.1
2013	9	3	0	12	24.5
2014	4	0	1	5	10.2
2015	5	1	2	8	16.3
Total	27	12	10	49	100

the criteria of "publication year, research model, sampling method, sampling size, sampling group, data collection tools, distribution of studies by number of data analysis methods and distribution of studies by subject areas".

Analysis of data

The data are formed by coding the studies in research analyzed by SPSS-21 program. Descriptive statistical calculations like frequency, percentage are used in the data analysis. The obtained results are shown in tables.

FINDINGS

In this part, the studies on mathematical modeling are evaluated based on publication year, research model, sampling method, sampling size, sampling group, data collection tools, distribution of studies by number of data analysis methods and distribution of studies by subject areas. The obtained findings are shown in tables.

Distribution of studies according to publication year

Distribution of the examined studies on mathematical modeling based on publication year and publication type is shown in Table 1 with the frequency and percentages.

According to Table 1, the studies on mathematical modeling were done in the year 2013 (f=12) in maximum number, while minimum number of studies were done in 2004, 2005, 2007 and 2009 (f=1); but it is determined as well that no study was done in 2006 in this subject area. Moreover, maximum number of studies on mathematical modeling was done in articles, while minimum ones were doctoral thesis.

Distribution of studies according to research model

The distribution of studies on mathematical modelling according to research model is shown in Table 2. It is determined that researchers mostly adopted qualitative method (f=27) while few adopted quantitative method (f=10) for the studies on mathematical modelling. Moreover, it could be easily seen that the researchers used qualitative (f=17) and quantitative (f=8) methods in articles on mathematical modeling more than their post graduate (f=1) and doctoral thesis (f=1) studies; but they preferred mixed methods (f=2) less.

Distribution of studies according to sampling method

The distribution of the studies on mathematical modeling within the scope of the research based on sampling method is given in Table 3. The data in Table 3 shows that the sampling method used is not mentioned in most of the studies (f=27) generally. Otherwise, it is determined that the researchers mostly use purposeful sampling method (f=14) in studies on mathematical modeling and few use cluster sampling method (f=1). Besides, the researchers prefer purposeful sampling method for post graduate (f=8) and doctoral thesis (f=5) studies more to the studies in articles; but they never adopt convenience sampling and cluster sampling method.

Distribution of studies according to sampling size

The distribution of the studies on mathematical modeling included in the study according to sampling size is presented in Table 4. It could be seen in Table 4 that

Table 2. Distribution of studies according to research model.

Research model	Publication type				
	Article	Post graduate	Doctorate	Total	Percentage
Quantitative	8	1	1	10	20.4
Qualitative	17	7	3	27	55.1
Mixed	2	4	6	12	24.5
Total	27	12	10	49	100

Table 3. Distribution of studies according to sampling method.

Sampling method	Publication type				
	Article	Post Graduate	Doctorate	Total	Percentage
Convenience sampling	2	0	0	2	4.1
Cluster sampling	1	0	0	1	2.0
Purposeful sampling	1	8	5	14	28.6
Criterion sampling	4	0	1	5	10.2
Unstated	19	4	4	27	55.1
Total	27	12	10	49	100

Table 4. Distribution of studies according to sampling size.

Sampling size	Publication type				
	Article	Post graduate	Doctorate	Total	Percentage
Between 1-30	16	4	3	23	46.9
Between 31-100	8	7	5	20	40.8
Between 101-200	2	0	2	4	8.2
201 and more	1	1	0	2	4.1
Total	27	12	10	49	100

researchers generally prefer the sampling size range between 1 and 30 (f=23). Sampling sizes are between 31 and 100 (f=20), between 101 and 200 (f=4) and finally 201 and more (f=2). The researchers have the tendency to work with more sampling numbers in article studies more than post graduate and doctoral thesis studies.

Distribution of studies according to sampling group

The distribution of the studies on mathematical modeling is shown in Table 5 based on sampling group. In Table 5, the researchers realize their studies on mathematical modeling mostly with university students. Teacher (f=9), primary school students (f=8), secondary school students (f=8), others (f=3) and high scholars with fewest number (f=1) follow this gradation. In addition to this, the researchers mostly include university students in their sampling group for article studies more than post graduate and doctoral thesis studies.

Distribution of studies according to numbers of data collection tools

The distribution of the studies on mathematical modeling based on numbers of data collection tools is shown in Table 6. According to Table 6, the researchers prefer to use “One Data Collection Tool (f=30)” more than “Two (f=13)” and “Three Data Collection Tools (f=6)”.

Distribution of studies according to number of data analysis methods

The distribution of the studies on mathematical modeling

Table 5. Distribution of studies according to sampling group.

Sampling group	Publication type				
	Article	Post graduate	Doctorate	Total	Percentage
Primary school students	4	3	1	8	16.3
Secondary school students	4	1	3	8	16.3
High-scholars	1	0	0	1	2.0
University students	10	6	4	20	40.8
Teacher	8	1	0	9	18.4
Others	0	1	2	3	6.1
Total	27	12	10	49	100

Table 6. Distribution of studies according to numbers of data collection tools.

Data collection tool	Frequency (f)	Percentage
One data collection tool	30	61.22
Two data collection tools	13	26.53
Three data collection tools	6	12.25
Total	49	100

Table 7. Distribution of studies according to number of data analysis methods.

Number of data analysis methods	Frequency (f)	Percentage
One analysis method	27	55.10
Two analysis methods	11	22.45
Three analysis methods	4	8.16
Unstated	7	14.28
Total	49	100

based on number of data analysis methods is shown in Table 7. It is seen in Table 7 that the researchers prefer One Analysis Method (f=27) more than Two Analysis Methods (f=11) and Three Analysis Methods (f=4). Moreover, there are studies (f=7) that do not specify the data analysis method as well.

Distribution of studies according to variables of subject areas

Distribution of the studies on mathematical modeling based on variables of subject areas is shown in Table 8. When the data in Table 8 were examined, it was determined that the researchers mostly concentrated on the variable (f=22) “effect of modelling method on modelling abilities’’ in the studies on mathematical modeling. Furthermore, it is determined that the researchers work less on “effect of modelling method on the abilities of attitude, view and modelling (f=3)”.

DISCUSSION

In this research, current situations and general tendencies of studies in Turkey on mathematical modelling between 2004 and 2015 are evaluated. These studies are classified according to publication year, research model, sampling method and size, sampling group, number of data collection tools, number of data analysis methods of studies, variables of subject area. Then, sufficient/ insufficient, advantageous/disadvantageous and important/unimportant sides of these studies could be understood. The frame that we create here will contribute to literature by making extensive and confidential solution in future studies on mathematical modelling.

It was determined by this research that most studies about mathematical modelling were done in 2003, and

Table 8. Distribution of studies according to variables of subject areas.

Subject area	Frequency (f)	Percentage
Effect of modelling method on modelling abilities	22	44.9
Effect of modelling method on success	7	14.3
Effect of modelling method on attitudes and views	11	22.4
Effect of modelling method on attitudes and views and modelling ability	3	6.1
Effect of modelling method on success and modelling ability	6	12.2
Total	49	100

least studies were done in 2004, 2005, 2007 and 2009. When both articles and thesis are considered, it is determined that most theses and articles were published in 2003 even though none of the studies were published in 2006. It is known that the studies in Turkey on mathematics education continue for about 20 years. In this period, the studies in mathematics area significantly increased and reconstructing of education faculties by YÖK played an important role (Türkmen, 2007). It is mentioned in a study on mathematics education that the number of studies in Turkey about mathematics education peaked up in 2005, but it started to decrease and got to the lowest point in 2009. This could be due to the inability to keep up with the standards of acceptance criteria, difficultly in making current studies, and increased cost percentage for abroad researches (Çiltaş et al., 2012).

In this research, researchers generally prefer qualitative research methods more than quantitative and mixed research methods. Hart et al. (2009) evaluated the researches in mathematics education area and determined that half of them used qualitative method. But, there is a study with the opposite (Çiltaş et al., 2012). Again quantitative method is used in article studies more than thesis studies and mixed method is preferred less at the same time. This could result from their unwillingness to step out of classic methods in studies related to mathematical modeling and their self-efficacy perceptions about applying it, even if they have enough theoretical and practical knowledge to use these methods. This finding is parallel to that of Aztekin et al. (2015), who reported that a small number of methods used are the requirement for obtaining more weight such as creating a parallel where inference is made and mixed research method is used like phenomenology and theory.

It can be seen in the findings of this research that purposeful sampling method is mostly used in studies on mathematical modeling and cluster sampling method is used less. And it is found that purposeful sampling method is preferred in post graduate and doctoral thesis studies more than article studies, but they did not adopt convenience sampling and cluster sampling method. Sampling might be an important way to get significant results besides the problem of content analysis, method and data collection tool. By this means, the researchers who use related sampling method could contribute to literature by showing an original and innovator approach.

Sampling size should be selected as large as possible in terms of increasing the power of representing the population (Büyüköztürk et al., 2016). In these studies, sampling size chosen is the range between 1 and 30. Sampling sizes of 201 and more are the least preferred. The findings show that the studies on mathematical modeling are generally realized by small samplings. However, the number of qualitative studies is higher than the number of quantitative studies for articles than thesis. That means, the researchers of articles prefer small sample sizes in qualitative researches because of the nature of this type of research. The reasons for choosing small samplings are shown by Sert and Seferoğlu (2012), as researchers must receive permission to meet the people who work in public enterprises and this makes the process difficult. That is why the studies are realized with the people who can be reached easily. So, making arrangements with officials to eliminate these difficulties or diminish them will make scientific research easier.

It is stated in research that mostly university students are included in sampling group, while primary school students and high scholars are preferred less. University students are preferred for researches more than other sampling groups (Aztekin and Şener, 2015; Güzel and Uğurel, 2010; Sokolowski, 2015). University students are mostly preferred for sampling groups in article studies more than post graduate and doctoral thesis studies. The reason why researchers choose them is because they are easily accessible and they have more knowledge and equipment than others. Another reason is that it is easy for researchers to get permission from their own university and faster than receiving permission from other departments. Mathematical modeling is a method that any person can use at every education level, and that is why there is need to do research on any person at every education level. It means, much things could be done more than concentrating on the same sampling group. Consequently, people at every level of education should be considered when choosing the sampling group for

future research.

Using more than one data analysis method and data collection tool require a large statistical method knowledge and application ability. In this research, it was determined that researchers used one data analysis method and one data collection tool in studies on mathematical modeling. This result shows that using only one data analysis method and one data collection tool will be enough for next studies on mathematical modeling. It will help to develop the data collection tool that will be used for future studies. So, using different analysis methods will be improved. High quality and original studies could be realized with these methods.

The research shows that the teaching process of mathematical modelling enhances the success and usage of mathematics in daily life (English and Watters, 2004; Sağırlı et al., 2010; Yıldırım and Işık, 2014). It is difficult to analyze the effects of mathematical modelling more systematically and in detail due to limited research and insufficient details relating to the teaching process of mathematical modelling. That is why it is stated that the teaching of mathematical modelling needs to be done under certain circumstances and conditions (Aztekin and Şener, 2015).

Mathematical modeling studies mostly concentrate on the “effect of modelling method on modelling abilities”, and few concentrate on the ‘”effect of modelling method on attitude, view and modelling abilities”. This tendency shows that the studies in mathematics education on modelling center on how to improve the modelling ability. The studies in this direction contribute to improving modelling ability. It is concluded that this tendency should be continued because learning by modelling could be provided by developing modelling ability. In Turkey, there are several studies on mathematical modelling after adopting a constructivist learning concept. This is seen in the study of Aztekin and Şener (2015), who evaluated all research as a whole. From this point, this research becomes more of an issue in terms of considering the studies on mathematical modeling generally, discussing the results and finally leading to future research.

Conflict of Interests

The author has not declared any conflicts of interests.

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REFERENCES

Altun M (2002). Mathematics teaching book. Istanbul, Turkey: Alfa Publishing Distribution.

Aztekin S, Şener AZ (2015). Content analysis of mathematical modelling researches in mathematics education area in Turkey: A meta-syntheses study. Educ. Sci. 40(178):139-161.

Baki A (2014). History of mathematics and philosophy. Ankara, Turkey: Pegem Academy.

Biber AÇ, Ulaş YM (2013). Evaluating the abilities of student’s in set problems. Turkish Studies 8(8):287-298.

Blum W (2002). ICMI Study 14: Applications and mathematical modeling education discussion document. Educ. Stud. Math. 51(1/2):149-171.

Büyüköztürk Ş, Çakmak EK, Akgün ÖE, Karadeniz Ş, Demirel F (2016). Scientific research methods (20th edition). Ankara, Turkey: Pegem Academy.

Chair HG, Murray DR, Sanfratello A (2012). Mathematical modeling handbook. The Consortium for mathematics and its applications Bedford, MA 01730. Retrieved February 22, 2016 from http://www.comap.com

Çiltaş A, Yılmaz K (2013). Mathematical models by primary education teacher candidates for statements of theorems. J. Educ. Teach. Res. 2(2):2146-9199.

Çiltaş A, Güler G, Sözbilir M (2012). Mathematics education researches in Turkey: Study of a content analysis. J. Pedagogy Theory Application 12(1):565-580.

Dede TA, Güzel BE (2013). Reviewing the designing process of creating model activity of mathematics teachers: Obesity problem. Primary Educ. Online 12(4):110-111.

Deniz D, Akgün L (2014). Secondary education student’s views about modelling method interclass applications. Trakya University J. Educ. 4(1):103-116.

Doruk BK (2010). The effect of mathematical modelling on transferring the mathematics to daily life (Unpublished doctoral dissertation). Hacettepe University, Pedagogy Institute, Ankara, Turkey.

Doruk BK, Umay A (2011). The effect of mathematical modeling on transferring mathematics into daily life. Hacettepe University J. Educ. 41:124-135.

English LD (2006). Mathematical modeling in the primary school: Children’s construction of a consumer guide. Educ. Stud. Math. 63:303-323.

English LD, Watters J (2004). Mathematical modelling with young children. In: Hoines, M.J. & Fuglestad, A.B. (Eds.), 28th Conference of the International Group for the Psychol. Math. Educ. 2:335-342.

Galbraith P (2012). Models of modelling: Genres, purposes or perspectives. J. Mathe. Modelling Applications 1(5):3-16.

Güzel EB, Uğurel I (2010). The relationship between pre-service mathematics teachers’ academic achievements in calculus and their mathematical modelling approaches. Ondokuz Mayıs University J. Educ. 29(1):69-90.

Hart LC, Smith SZ, Swars SL, Smith ME (2009). An examination of research methods in mathematics education: 1995-2005. J. Mixed Methods Res. 3(1):26-41.

Kaiser G, Blomhøj M, Sriraman B (2006). Towards a didactical theory for mathematical modeling, Zentralblatt für Didaktik der Mathematik, 38(2):82-85.

Lawson D, Marion G (2008). An introduction to mathematical modelling. Retrieved May 24, 2016 from www.maths.bris.ac.uk/~madjl/course_text.pdf

Lingefjärd T (2006). Faces of mathematical modelling. ZDM. Int. J. Mathe. Educ. 38(2):96-112.

Ministry of National Education (2009). Primary education school mathematics lesson (6-8 grades) education program. Ankara, Turkey: Headship of Public Books Printing House.

Ministry of National Education (2013). Secondary education mathematics lesson teaching program. Ankara, Turkey: Headship of Public Books Printing House.

Niss M (2003). Mathematical competencies and the learning of mathematics: The Danish KOM Project. In: Gagatsis, A./Papastavridis, S. (Eds), 3rd Mediterranean Conference on Mathematical Education. Athens: The Hellenic Mathematical Society, pp. 115-124.

Özdemir G, Işık A (2015). Teacher views about teaching the areas and volumes of solids by mathematical model and mathematical modelling method. Kastamonu Educ. J. 23(3):1251-1276.
Sağırlı ÖM, Kırmacı U, Bulut S (2010). The effects of mathematical modelling method on secondary school students' academic achievements and self-regulated learning skills. Institute Sci. Technol. J. 3(2):221-247.
Sert G, Seferoğlu SS (2012). A look to the researches evaluate using technology situations of teachers: study of a content analysis. Comput. Educ. 14:46.
Sokolowski A (2015). The Effects of mathematical modelling on students' achievement-meta-analysis of research. The IAFOR J. Educ. 3:1.
Tabak H, Ahi B, Bozdemir H, Sarı MH (2010). Modelling abilities of primary education students in mathematics lesson. E-J. New World Sci. Acad. 5(4):1C0216.
Thomas K, Hart J (2010). Pre-service teacher perceptions of model eliciting activities. In R. Lesh et al. (Eds.), Modeling students' mathematical modeling competencies (531-539). New York, NY: Springer Science & Business Media.
Tuna A, Biber AÇ, Yurt N (2013). Mathematical modeling skills of prospective mathematics teachers. GEFAD / GUJGEF 33(1):129-146.
Türkmen L (2007). The history of development of Turkish elementary teacher education and the place of science courses in the curriculum. Eurasia J. Math. Sci. Technol. Educ. 3(4):327-341.
Umay A (2007). Our old school friend is the new face of school math. Ankara, Turkey: Aydan Web Facilities.
Yıldırım Z, Işık A (2014). The effect of mathematical modelling activities on 5th class student's academic success in mathematics lesson. Kastamonu Educ. J. 23(2):581-600.
Weber RP (1990). Basic content analysis (2nd edt.). Londra: Sage Printing.