The Examination of the Postgraduate Theses on Models and Modelling in Science Education in Turkey

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Abstract

The models and modelling takes an important place in the teaching of science. The purpose of this research was to examine the postgraduate theses made in Turkey about models and modelling in the science education field by using the content analysis method. When the postgraduate theses were examined in respect to the purpose of the research, it has been determined that the number of the experimental research studies which were aimed to examine the efficiency of the model/modelling based teaching method was more than the others. In the examined theses, it has been identified that quantitative methods were more preferred as a research method. In the sense of the research sample, it has been determined that the number of research studies on the middle school level, especially those on 7th grade students was numerically more. It was seen that the most used data collection tool was conceptual test. The most examined variables in the theses were the achievement level and the mental model of the participants. The most preferred subjects were the "Atom and its structure" and the "Astronomy". Based on the results, some suggestions were presented to future research studies related to models and modelling in science education.

Keywords: Content Analysis, Postgraduate Thesis, Models in Science Education, Modelling in Science Education.

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INTRODUCTION

The students have many difficulties in science education. In many research studies about science education, it was stated that students could not understand science concepts in the scientific sense (Bayram et al., 1997; Calış, 2010; Coştu et al., 2007; Kurnaz & Değermenci, 2012). Science contains abstract concepts and processes due to its nature. Thus, the models are widely used to help people to understand and embody the abstract concepts and complex processes in science. In these premises, models and modelling have become a crucial and central role in both doing and teaching of science (Devi et al., 1996; Düşkün & Ünal, 2015; Güneş et al., 2004; Ogan-Bekiroglu, 2006; Treagust et al., 2002).

Gilbert et al. (2000) mention three aspects about the importance of models:

- The models are the basic tools in the process of an individual's perception and understanding of a fact/knowledge.
- The phases of developing a model and testing it play an important role in the process of developing, testing and sharing scientific knowledge.
- The models are one of the most important outputs and products of science.

When the literature examined, it was seen that different definitions of models are made by various researchers. According to Ingham and Gilbert (1991), a model is a simplified representation that concentrates on specific aspects of a system. According to Paton (1996), a model is scientific and mental activities used to ease the events that are seen as complicated by people. As to Gilbert (2011), a model is a system comprising of objects, symbols and connections so as to represent a system in real world which is called as 'target'. According to Gilbert et al. (2000), it is a representation of an object, fact, process or idea. According to Hestenes (2006), a model is a simple representation of actual or imaginary structures which are interrelated to each other. A model can be a representation of a concrete object or process (Harrison & Treagust, 1998). Similar to the variety of the definition of models, it was observed that there was a variety in the definition of modelling process. According to Greca and Moreira (2000), modelling is correlating semantic relations between the facts/objects and the theories. According to Gilbert et al. (2000), modelling is a crucial process in constructing, evaluating, and spreading the scientific knowledge. As to Schwarz et al. (2009), the modelling is the central part of science literacy; it is a scientific process which contains constructing a model, using the model, evaluating the model and revision of the model.

Similar to the variety of the definition of models, it is seen that there is also differences in the categorization of the models. Harrison and Treagust (2000) have categorized models as; scale models, pedagogical analogical models, symbolic (iconic) models, mathematical models, theoretical models, maps, diagrams and tables, concept process models, simulation, mental models, synthetic models. Ünal and Ergin (2006) have categorized models as; open models and mental models. On the other hand, Ornek (2008) have categorized models under two headings as; mental models and conceptual models.

The use of models and modelling as a teaching/learning way in the science classes has brought out “models or modelling based teaching” concept. Model based teaching is a teaching approach where the involved knowledge sources, teaching activities and teaching strategies are used all together to simplify the construction of a mental model within both individuals and learning groups (Gobert & Buckley, 2000). Besides, modelling based teaching is a teaching approach in where modelling activities are conducted in the teaching process, and in where students comprehend the nature of science better and take an active role in the process through setting a model and model constructing activities (Harrison & Treagust, 1998; Schwarz, 2009; Sins et al., 2009; Windschitl et al., 2008).

When the literature examined, it was seen model/modelling based teaching method helps students to;

- develop a positive attitude against science lessons,
- increase their motivations towards science lessons,
- take an active role in the teaching process,
- build and develop their mental models,
- raise their academic success.

As a result of the literature search, any research which analysis the articles or postgraduate theses on models and modelling in science education has not been encountered. Examining of the research studies on models and modelling in science education is of great importance in terms of identifying tendencies in these research studies, revealing the deficiencies in the related literature and shedding light on future research studies.

The purpose of this research was to present the tendencies of the 91 postgraduate theses that conducted on model and modelling in science education in Turkey by using the content analysis method. The obtained findings of the research are believed to light the way for future research studies by revealing the general condition of the research studies on models and modelling in science education.

RESEARCH METHODOLOGY

In this research, the Turkish postgraduate theses about models and modelling in science education have been examined. While the research has been planned as a qualitative research, document review has been used as the data collection method. According to Yıldırım and Şimsek (2011), document reviews are the analysis of the materials containing the knowledge about the events and facts that are aimed to be examined. The content analysis method has been used for analysing the obtained data. The purpose of the content analysis is to reveal the concepts, that can explain the obtained data, and the connections between these concepts, and to present these in a system that readers can understand by categorizing them in particular frameworks of the subject (Yıldırım & Şimsek, 2011). Theses within the scope of the research were theses that conducted on model and modelling in science education in Turkey. This research was completed in January 2020.

Population and Sample

As of November 2019, the number of completed theses in the field of "Education and Training" in Turkey was 49.261 of which 40.948 were master's thesis and 8.248 were doctoral dissertation (T.C. Council of Higher Education Thesis Center, 2019). The purpose of this research was to examine the trends of theses that were conducted on model and modelling topics in science education. The population of the research was the Turkish postgraduate theses about models and modelling in science education. Therefore, the target population was all theses on the subject of science education and model and modelling. The target population was 91 theses, as described in the subsection.

Data Collection and the Analysis of Data

In the process of collecting the data, a search has been made for the postgraduate theses which was under the 'Education and Training' subject area in the Turkish Council of Higher Education Thesis Center, and which contains the 'model' and/or 'modelling' keywords. As a result of the search, 1576

thesis records were reached. The abstracts, keywords and titles of the theses obtained were examined to analysis whether the theses were about model and modelling in science education. The 91 of these were determined to be related to science education and these research studies were included to the present research for detailed examination. These theses were completed between 2001 and 2019. 8 of 91 theses were in English. A thesis analysis form (TAF) that is presented in the Appendix 1 was used to analyse and codify the theses. While creating the TAF, the criteria used in the studies examining articles or theses on different topics in the literature by using content analysis method were taken into consideration. The postgraduate theses were independently reviewed by both researchers using the TAF. Cohen Kappa statistics were calculated among the coders for the reliability of the research. According to the calculated Cohen Kappa coefficient (> 0.80), compatibility between coders is excellent (Landis & Koch, 1977). The postgraduate theses were examined in detail and coded by using the TAF according to their publication years, purposes, methods, samples, data collection instruments, research variables, and the subject to be focused. By using the TAF, the collected data has been presented in the findings in graphics and tables together with percentages and frequency values.

RESULTS

The findings obtained as a result of the analysis of the Turkish postgraduate theses according to the determined criteria in TAF has been shown in graphics and tables together with percentages and frequency values by using the descriptive statistics method. The postgraduate theses reviewed are shown in Figure 1 according to their publication years.

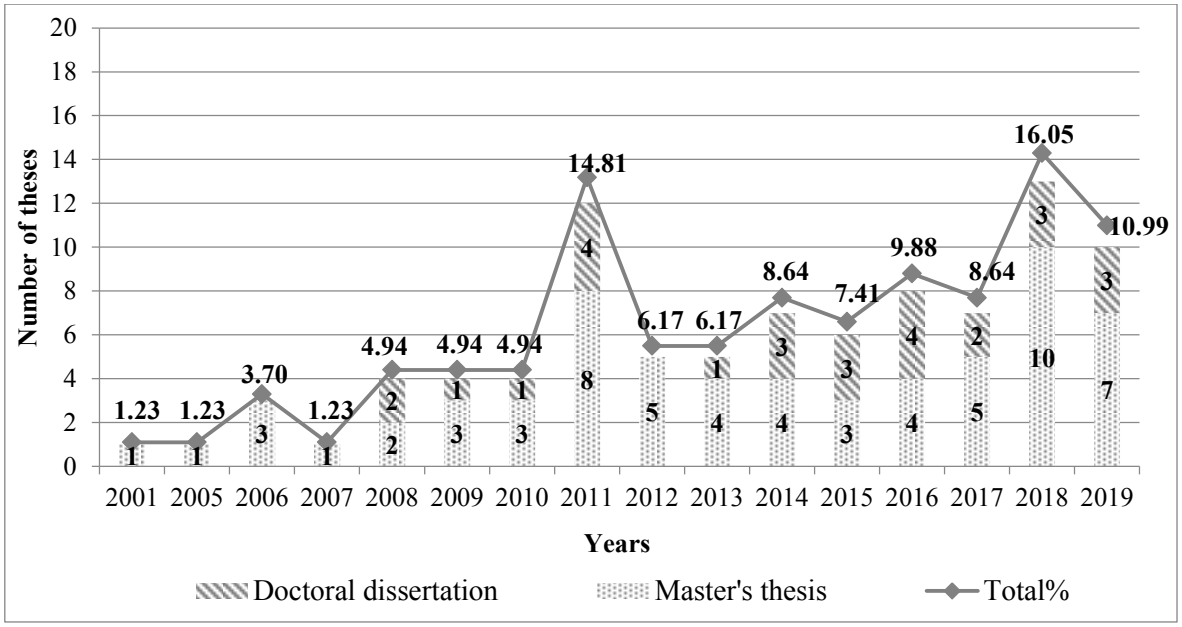

Figure 1. The distribution of the theses examined according to their publication years

According to Figure 1, it was seen that the number of the Turkish theses on models and modelling in science education had increased to the present day. Within the examined theses, the number of the theses in year 2018 was the highest (about 16%).

The distribution of the theses examined according to their research purposes are given in Table 1.

Table 1. The distribution of the theses examined according to their research purposes

Purpose of research	*f*			
	Doctoral dissertation	Master's thesis	Total	Total (%)
The examination of the effects of model/modelling based teaching method	23	35	58	63.7
Determination of the mental models of participants of a selected concept	1	21	22	24.2
Other	3	8	11	12.1
Total	27	64	91	100

As seen in Table 1, almost all of the doctoral dissertations and more than half of the master theses in Turkey were aimed to examine the effects of models or modelling based teaching process on different variables (63.7%). In most of these research studies, quasi-experimental design was used, and the effect of models or modelling based teaching process had been examined by using experimental and control groups. Most of the resting research studies were those aimed to examine the mental models of a target group about a specified subject. These were generally designed as a survey or case research. It was seen that five studies aimed to examine the respondents' views about models/modelling and their use in science or science education, while two of them aimed to examine the effect of various teaching methods on the development of mental models of students. Moreover, one research which aimed to develop a scale for evaluating modelling skills, one research which aimed to develop the modelling skills of students, one research which aimed to determine the factors affecting the modelling process, and one research focused on designing/constructing models and modelling process were included in "other" category.

Table 2 shows the distribution of the theses examined according to their selected/used research method.

Table 2. The distribution of the examined theses in terms of their research methods

Research method	*f*	%
Quantitative	43	47.3
Qualitative	29	31.9
Mixed	19	20.9
Total	91	100

According to Table 2, it has been detected that the quantitative method (47.3%) was further more used in the postgraduate theses. It was followed respectively by the qualitative research method with 31.9% and the mixed method with 20.9%.

The distribution of the theses examined in this research content according to their sample is given in Table 3.

Table 3. The distribution of the theses examined according to their sample

Sample	Sample Group	*f*	%
Undergraduate		33	26.0
	Pre-service science teachers	17	13.4
	Pre-service physics teachers	5	3.9
	Pre-service chemistry teachers	4	3.1
	Pre-service primary school mathematics teachers	1	0.8
	Pre-service preschool teachers	2	1.6
	Pre-service elementary school teachers	2	1.6
	Pre-service secondary school mathematics teachers	1	0.8
	Medical faculty students	1	0.8

Associate degree program		1	0.8
	1th grade	1	0.8
Secondary school (9-12)		19	15.0
	9th grade	7	5.5
	10th grade	7	5.5
	11th grade	3	2.4
	12th grade	2	1.6
Middle school (5-8)		53	41.7
	5th grade	5	3.9
	6th grade	14	11.0
	7th grade	24	18.9
	8th grade	10	7.9
Primary school (1-4)		5	3.9
	3th grade	1	0.8
	4th grade	4	3.1
Instructor		16	12.6
	Science teacher	8	6.3
	Physics teacher	3	2.4
	Chemistry teacher	2	1.6
	Biology teacher	1	0.8
	Lecturer	2	1.6
Total		127	100

According to Table 3, it has been specified that the Turkish postgraduate theses on models and modelling in science education were further more applied with middle school students (41.7%). In the middle school level, the research studies were mostly conducted with 7th grade students (18.9%). The most research in the undergraduate level (26%) conducted with pre-service science teachers (13.4%) In some of the theses examined, the sample consisted of respondents from different educational levels. It was found that the numbers of the theses conducted with associate degree students and primary school students were quite low. No research studies conducted with preschool students have been encountered. All of the examined theses except one have included students in their samples. Moreover, there have been theses in which the sample includes teachers and lecturers as well as the students.

The distribution of the theses examined according to their selected/used data collection tools is presented in Table 4.

Table 4. The distribution of the theses examined in terms of the data collection tools used

Data collection tool	***f***	***%***
Achievement test	37	17.5
Activity papers/documents	7	3.3
Conceptual test	51	24.1
Diary	2	0.9
Interview	46	21.7
Observation	12	5.7
Scale	27	12.7
Skill test	16	7.6
Survey	9	4.3
Other	5	2.4
Total	212	100

As seen in Table 4, the most used data collection tools were conceptual tests (24.1%) and interviews (21.7%) in the theses examined. Besides these, achievement test (17.5%) was frequently used as data collection tool in the theses examined. While drawings and open-ended questions were

used in most of the conceptual tests, it has been seen that two-tier, three-tier, multiple-choice, and true/false question types were less used in the theses examined. On the other hand, it has been seen that the majority of the achievement tests consisted of multiple-choice questions. The interview as a data collection tool was generally used to determine the respondents' mental models and their conceptual understanding levels on a specific subject/concept, or to determine their views on the teaching applications used in the research. Also, in a lot of the research studies, it has been seen that more than one data collection tool was used together. Exam scores of students, student homeworks and etc. were rarely used as data collection tools in the theses examined, so they were included in "other" category.

The distribution of the theses examined according to their examined variables is shown in Table 5.

Table 5. The distribution of the theses examined in terms of their examined variables

Variable	***f***	***%***
Achievement Level	37	18.6
Anxiety	2	1.0
Attitude	13	6.5
Conceptual Change	6	3.0
Conceptual Understanding Level	33	16.6
Critical Thinking Skill	3	1.5
Logical Thinking Skill	2	1.0
Mental Model	37	18.6
Modelling Skill	2	1.0
Motivation	4	2.0
Participant Views	27	13.6
Retention	12	6.0
Scientific Creativity Level	3	1.5
Scientific Process Skill	6	3.0
Spatial Skill	3	1.5
Views on the Nature of Science	4	1.5
Other	5	2.5
Total	199	100

As seen in Table 5, the achievement level (18.6%) and the mental model (18.6%) were the most examined variables in the theses examined. These variables were followed by conceptual understanding level (16.6%) and participant views (13.6%) variables. "Self-efficiency", "learning approaches", "problem solving skill", "goal setting strategy tendencies", and "ontological belief" variables were included in "other" category. In a great deal of the theses, it has been seen that more than one variable was examined. On the other hand, it has been seen that the number of the research studies which were oriented to research 21st century skills like the problem solving and critical thinking were very low.

The distribution of the theses examined according to the concepts/subjects to be focused is seen in Table 6.

Table 6. The distribution of the examined theses in terms of the subjects to be focused

Field	Concept/Subject	*f*	%
Biology			
	Cell/Cell Division/Inheritance	8	8.4
	Circulatory system	1	1.1
	Digestive System	3	3.2
	Environment and Environmental Issues	6	6.3
	Foods	1	1.1
	Microorganisms	1	1.1
	Plants	2	2.1
	Reproduction System	1	1.1
	Respiratory System	3	3.2
	Urinary System	1	1.1
	Total	27	28.4
	Astronomy	12	12.6
Physics	Dynamic	1	1.1
	Electricity	9	9.5
	Energy	2	2.1
	Light	3	3.2
	Machines	1	1.1
	Pressure	1	1.1
	Projectile Motion	1	1.1
	Sound	2	2.1
	Total	32	33.7
	Chemical Bonding	7	7.4
Chemistry	Atom and Its Structure	12	12.6
	Earth Crust	2	2.1
	Chemical Reactions	4	4.2
	Gases	1	1.1
	Solutions	1	1.1
	Electrochemistry	1	1.1
	Matter and Heat	8	8.4
	Total	36	37.9
Total		95	100

As seen in Table 6, it has been determined that the most researched field was chemistry (37.9%) in the theses examined. The most studied subject in chemistry was “Atom and Its Structure” (12.6%). The field of chemistry was followed by physics (33.7%) field and biology (28.4%) field. While the most studied subject in the field of physics was astronomy (12.6%), the most studied subject in the biology field was cell / cell division (8.4%). It has been seen that some theses have studied on more than one subject. This was the reason why the total number of subjects is 95 in Table 6.

DISCUSSION

It has been seen that the first Turkish thesis which was accessed and studied on models and modelling in science education field was published in the year 2001. It can be deduced that the number of the theses on models and modelling in science education have increased to the present day. However, the upward trend observed after the year of 2011 was not as high as in 2001-2011. The reason for this may be that the recent theses on models and modelling in science education have focused on a specific type of models such as analogy, simulation, and etc., rather than using of all types of models. Moreover, the authors may not be emphasized that the teaching materials (analogy, simulation, etc.) used in their thesis are the types of model. The recent research studies in this field could be presented within the following contents like analogies, multimedia use, augmented reality, virtual reality, mobile learning, etc.

According to the aims of the theses examined, it was seen that they were gathered into two categories. These were; a) the research studies which aim to examine the effect of model/modelling

based instruction method in terms of different variables such as students understanding level and achievement or to develop participants' mental models on a specified subject, b) the research studies which aim to find out the existing mental models of the participants towards a specific subject/concept. Almost all of the doctoral dissertations and most of the master theses were intervention research aiming to determine the effects of model/modelling based instruction on different variables. This situation shows similarity with some of the earlier research results, while it differs with some others. Deniş-Çeliker and Uçar (2015), who examined the theses on science education in Turkey, have reported that experimental research design was generally used in the examined theses and remarked that the rate of using experimental research design in doctoral dissertations was higher than that in master theses. While various literature review studies on mathematics education (Baki et al., 2011; F. Ulutaş & Ubuz, 2008), physics education (Kaltakçı-Gürel et al., 2017) and science education in Turkey (Küçüközer, 2016) have reported that the studies including an intervention and having experimental design were predominant, the some literature review studies on chemistry education (B. Ulutaş et al., 2015) and biology education (Gul & Sozbilir, 2015) have reported that the research studies aiming to determine a current statement without any intervention were the majority. The rate of the intervention research studies in doctoral dissertations which are long-termed and in-depth research studies are higher than that in master's theses which are generally short-term research studies in contrast to them. Therefore, this difference in the results of various research studies may be due to the proportion of doctoral dissertations and master theses in research studies they examined in the context of their research studies.

Although it was specified that the number of the thesis using the qualitative and mixed research methods was gradually increasing towards today, it has been determined that the quantitative research method is used much more in the Turkish theses examined in this research. This result shows similarity with the results of various literature review studies on education (B. Ulutaş et al., 2015; Banning & Folkestad, 2012; Derman, 2017; Doğru et al., 2012; Kaltakçı-Gürel et al., 2017; Önder et al., 2013). Unlike this result of current research, it has been found out that while the mixed method is predominant in the various literature review studies on science education (Küçüközer, 2016), chemistry education (Teo et al., 2014), augmented reality based instructional technologies (Bacca et al., 2014). Besides, the qualitative method is predominant in the some literature review studies science education (O'Toole et al., 2018), modelling in mathematics education (Aztekin & Taşpınar-Şener, 2015; Albayrak & Çiltaş, 2017). The reason of the contradiction in the generated results of the research studies examining theses or articles could be due to the fact that the selection for the research method shows difference according to different fields, purposes, subjects and years.

When they were examined in terms of their samples, it was found that most of them were conducted with the middle school students. Especially, the number of the research studies conducted with 7th grade students was the highest. The "high school entrance exam" is performed at the end of 8th grade in Turkey. It can be said that researchers preferred 7th and 6th grade students rather than 8th grade as a sample in their studies due to this exam. In the theses examined in this research, the other group that was the most studied as a research sample was undergraduate students. It was seen that the most used sample group in undergraduate level was pre-service science teachers. However, it was determined that the number of research studies conducted with science teachers and primary school students were very low. Similarly, Küçüközer (2016) reported that the majority of the theses were conducted with pre-service teachers and middle school students, especially with 7th grade students. O'Toole et al. (2018) reported that the most preferred sample group in the research on science education was middle school students. On the other hand, the results of various studies examining research on chemistry education (Teo et al., 2014; B. Ulutaş et al., 2015), mathematical models and modelling (Albayrak & Çiltaş, 2017), physics education (Önder et al., 2013), biology education (Gul & Sozbilir, 2015) and augmented reality based instructional technologies (Bacca et al., 2014) were in harmony with this research, and it has been reported that the number of research studies conducted with undergraduate students as a sample group was higher than the other groups. It is considered that undergraduate students are preferred as the sample because they are easy and accessible for

researchers. However, the level or the character of the sample may vary depending on the research field, subject and purpose.

The most used data collection instruments in the postgraduate theses on models and modelling in science education were specified to be the conceptual tests and the interviews. This shows that it has been aimed to determine the effect of a teaching intervention based on models and modelling on student's conceptual understanding levels in most of the theses examined. At this point, an important confusion catches the attention in the theses examined in this research. It was determined that interviews, the other commonly used data collection tool in the theses, was generally used to determine the participants' mental models, conceptual understanding levels or their views about the teaching process including models or modelling process. In most of the theses examined, it was determined that more than one data collection tool was used together. Similar and different results were obtained in various research studies in the literature. In various literature review studies on biology education studies (Gul & Sozbilir, 2015), on physics education studies (Kaltakçı-Gürel et al., 2017; Önder et al., 2013) and on mathematics education studies (Baki et al., 2011), it was also reported that the most used data collection tool in the research studies was achievement test. However, in some literature review studies on mathematical models and modelling (Albayrak & Çiltaş, 2017), on augmented reality (Bacca et al., 2014), it was reported that the most used data collection tool in the research studies was interview. In recent years, considering that the emphasis in science education research studies has been focused on concept teaching and that there has been a struggle in the research studies for improving students' understanding levels of basic science concepts by using various teaching methods and strategies, it is an expected result that the most widely used data collection tool will be conceptual tests.

In the examined theses, it has been concluded that the most discussed variables were the achievement level and the mental model. This matter shows that it is in the line with the research studies in various fields about education that success is the variable of students' achievement (Deniş-Çeliker & Uçar, 2015; Derman, 2017; Önder et al., 2013; B. Ulutaş et al., 2015). Besides, it is an expected result that mental model is one of the most examined variables in postgraduate theses. Students' understanding levels and achievement about a subject in science depends on having scientifically correct mental models about it. Therefore, to ensure an effective concept teaching, the students' existing mental models should be defined firstly and then they should be tried to be developed. Nowadays, critical thinking, communication, knowledge management, cooperation skills are accepted as 21st century skills (Ananiadou & Claro, 2009; Binkley et al., 2012; Voogt & Roblin, 2012). Model or modelling based teaching, could help to develop critical thinking, abstraction, and problem solving skills. On the other hand, the opposite of this relation is also possible. Student's critical thinking, abstraction, and problem solving skills could affect their modelling skills. However, there were not enough research studies examining this relationship, in other words the relationship between 21st century skills and model use or modelling ability in the context of cause-effect. Moreover, it was determined that the examined postgraduate theses predominately focused on cognitive domain. It has been seen that the number of theses which examined the affective behaviours domain, which can directly or implicitly affect students' achievement, or the important components of affective behaviours domain like motivation, attitude, self-sufficiency, self-confidence, and anxiety was quite limited.

In the postgraduate theses examined within this research, it has been specified that most of the theses were related to chemistry discipline. It was seen that the most examined subject in chemistry field was the "atom and its structure". Due to its abstract structure, chemistry was a discipline which widely contains models and modelling. In the postgraduate theses examined within the research, it has been seen that the "astronomy" subject was the most researched subject in physics discipline, and the "cell/cell division/inheritance" subject in the biology field. These subjects being abstract, being occurred in the micro/ macro dimension, and being difficult to understand for the students could be the reason of this situation. In their research where they examined the postgraduate theses in science education, Doğru et al. (2012) have reported that "atom and its structure" in the field of chemistry,

"ecosystem and ecology" in the field of biology, and "electric" and "force and motion" in the field of physics were the most studied subjects.

CONCLUSIONS AND IMPLICATIONS

The aim of this research was to examine the postgraduate theses made in Turkey about models and modelling in the science education field. In this context, 91 postgraduate theses were examined in detail and coded by using the TAF according to their year, thesis type, department, purpose, method, sample and its size, data collection instrument, research variables, and the subject to be focused. When the postgraduate theses were examined in respect to the purpose of the research, it has been determined that the number of the experimental research studies which were aimed to examine the efficiency of the model/modelling based teaching method was more than the others. In the examined theses, it has been identified that quantitative methods were more preferred as a research method. In the sense of the research sample, it has been determined that the number of research studies on the middle school level, especially those on 7th grade students was numerically more. It was seen that the most used data collection tool was conceptual test. The most examined variables in the theses were the achievement level and the mental model. The most preferred subjects were the "Atom and its structure" and the "Astronomy". In the light of the obtained findings, some suggestions were presented to future research studies related to models and modelling in science education. Based on the results of this research, following suggestions can be made;

Research studies about models and modelling can be planned especially for primary school students.

Research studies should use different teaching ways such as collaborative learning, problem-based learning and project-based learning together with the model-based instruction method.

Research studies should examine the effect of 21st century skills like critical thinking, problem solving and reflective thinking on students' modelling skill.

Research studies on the effect of the affective factors (attitude, interest, motivation, and anxiety), which can effect students' achievement, on the development of students' mental models can be planned.

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Appendix 1. The thesis analysis form (TAF)

Thesis Tag		
Thesis Title		
Author		
Year of Publication		
Type	( ) Master's Thesis	( ) Doctoral Dissertation
Research Method	Research Aim	
( ) Quantitative	( ) The Effect of Model/Modelling Based Teaching	
( ) Qualitative	( ) Determination of the Mental Models	
( ) Mixed	( ) Other	
Sample		
( ) Undergraduate Program:….		
( ) Associate Degree Program:….		
( ) High School/Field/Class:…..		
( ) Middle School/ Field/Class:…..		
( ) Primary School/Class:…….		
( ) Pre-school		
( ) Instructor		
Data Collection Instrument	Examined Variable	
( ) Achievement Test	( ) Achievement Level	
( ) Activity Papers/Documents	( ) Anxiety	
( ) Conceptual Test	( ) Attitude	
( ) Diary	( ) Conceptual Change	
( ) Interview	( ) Conceptual Understanding Level	
( ) Observation	( ) Critical Thinking Skill	
( ) Scale	( ) Mental Model	
( ) Skill Test	( ) Motivation	
( ) Survey	( ) Participant Views	
( ) Other	( ) Retention	
	( ) Scientific Creativity Level	
	( ) Scientific Process Skill	
	( ) Spatial Skill	
	( ) Views on the Nature of Science	
	( ) Other	
Field/Topic		
( ) Biology		
( ) Physics		
( ) Chemistry		