Research Article **AJERR (2016), Vol. 1, Issue 01**

American Journal of Educational Research and Reviews (AJERR)

Teacher's Views Regarding the Development of Students' Cognitive Modelling Competencies and Modelling Implementation Process

Ayşe TEKİN DEDE and Süha YILMAZ

[1] Dr, Dokuz Eylül University, Izmir, TURKEY
[2]Assoc. Prof. Dr., Dokuz Eylül University, Izmir, TURKEY

ABSTRACT

The purpose of the study is to reveal a mathematics teacher's views regarding the development of 6th grade students' cognitive modelling competencies and modelling implementation process. She conducted a long-term modelling sequences aiming at the competency development and was interviewed after the implementation process. Her answers were analyzed by using content analysis and the views were gathered under some themes and codes. It was seen that the views were shaped under seven themes as providing the development of each modelling competency, development of cognitive modelling competencies, factors contributing the development of cognitive modelling competencies, factors preventing the development of cognitive modelling competencies, implementation process, future implementations and factors required to be fixed in the implementation process. Some strategies supporting the development of the cognitive modelling competencies were appeared from her statements. She also indicated her general thoughts about the strengths and weaknesses of the implementation process. It is suggested for further studies to utilize the factors and strategies revealed in the study for planning modelling implementations.

Key words: Cognitive modelling competency, mathematics teacher, modelling sequence, teacher view.

***Correspondence to Author:**
Ayşe Tekin Dede
Dokuz Eylül University, Izmir, TURKEY.
E-mail:ayse.tekin @ deu.edu.tr

How to cite this article:
Ayşe TEKİN DEDE and Süha YILMAZ. Toxicological Teacher's Views Regarding the Development of Students' Cognitive Modelling Competencies and Modelling Implementation Process. American Journal of Educational Research and Reviews, 2016,1(1): 0001-0010.

Accepted 10 September 2016; published 10 September 2016.

eSciencePublisher
eSciPub LLC, Houston, TX USA.
Website: http://escipub.com/

Introduction

Mathematics education researches in recent years become focusing on learning activities in which students are engaged in searching solution ways for the problems to be encountered in their daily lives. Mathematical modelling which can be used both for aim and method in such learning activities gains importance and is given a place in curricula of different countries since 1980s. In the didactic discussions, the question of how mathematical modelling and its applications can be integrated into daily school lessons is discussed (Maaß, 2006). In this integration process, to what extent students have modelling competencies while working on modelling tasks and whether they can use them effectively have also been the scope of the studies. Modelling competencies, which are frequently discussed in the modelling literature, are defined as the skills and abilities of complementing the modelling process purposively and properly, at which time it is stated that the individual should be willing in this process (Kaiser & Maaß, 2007; Kaiser & Schwarz, 2006; Kaiser, Schwarz & Tiedemann, 2010; Maaß, 2006). When considered modelling competencies during modelling process according to the afore-said definition, the cognitive frame of modelling comes to the forefront. Because to define, interpret and explain the approaches of students working on modelling tasks in parallel with the modelling process, the cognitive modelling approach is seen necessary (Blum, 2011). In the context of this approach, the cognitive modelling competencies are discussed in working through the steps of the modelling process.

Although the modelling process and its stages are defined by the researchers according to their perspectives, it can be seen that all of them show similarities (Blum & Borromeo Ferri, 2009; Borromeo Ferri, 2006). Since the cognitive viewpoint of modelling is considered in this study, the cognitive modelling competencies are regarded as understanding the problem, simplifying, mathematizing, working mathematically, interpreting and validating in the frame of the Modelling Cycle under a Cognitive Perspective (Borromeo Ferri, 2006). It is seen there are different implementations in the literature to enable the development of students' cognitive modelling competencies. While some of them considers the integration of modelling units into mathematics lessons (Biccard, 2010; Bracke & Geiger, 2011; Ji, 2012; Maaß, 2005; 2006), some of them highlights modelling projects (Blomhoj & Hojgaard Jensen, 2010; Grünewald, 2012; 2013).

This study aims to reveal the views of the mathematics teacher conducting a long-term modelling implementation aiming at the development of sixth grade students' cognitive modelling competencies. After the implementation process, the views regarding the strategies used for the competency development are tried to be determined. In addition, strengths and weaknesses of the implementation process are tried to be discussed by taking general opinions about the process. The studies examining the views of mathematics teachers on mathematical modelling discuss their existing modelling knowledge and the integration of modelling into teaching (Işık & Mercan, 2015; Özdemir & Işık, 2015; Tekin, Hıdıroğlu, Kula, Bukova Güzel & Uğurel, 2012; Tekin Dede & Bukova Güzel, 2013). Because the views on the conducted modelling implementation and the strategies used for the development of the students' cognitive modelling competencies instead of mathematical modelling and its integration are revealed, the study is regarded as the first in the literature. In addition, the fact that the teacher has modelling experience since she conducted a long term modelling implementation distinguished this study from others in the literature.

Method

This study is a qualitative study with regards to collecting and analyzing the data with the purpose of identifying the teacher's views conducting a modelling implementation.

Participants

The participant of the study is a volunteer elementary mathematics teacher having twelve-year teaching experience. The teacher, who had a limited knowledge on modelling from different workshops and seminars, was trained by the first researcher about modelling process, modelling problems, modelling implementations and possible modelling approaches of students. She conducted modelling sequences in a selective lesson named Mathematics Applications with sixth graders during seven months. The so-called sequences were designed with the purpose of providing modelling experiences for the students who had no modelling experience and developing their cognitive modelling competencies. The 7-month implementation was composed of twelve modelling sequences developed by the teacher and the researchers. After each implementation, the previous one was evaluated in general terms and the cognitive modelling competencies of the students were examined. In the examinations at issue, it was determined in which competencies the students made progress, in which ones they had troubles and the general problems encountered, and the content of next implementation was decided. In the implementation process of the modelling sequences, the students were divided into five working groups and worked on modelling tasks. While conducting the implementations, the teacher acted as cognitive coach (Blum & Leiβ, 2007; Chan, 2010; Chan & Foong, 2013) when the students were working on the problems. She asked the questions to reveal the thought processes of the students and supported them to work in groups.

Data Collection Tools

An interview was conducted in the end of the implementation of the modelling sequences. De Marrais (2004) explains that interview is a conversation process including the interviewer and the participant by focusing on the questions prepared towards the area to study (cited in Merriam, 2013). There are three types of interviews according the amount of structuring as structured, semi-structured and unstructured (Çepni, 2009; Güler, Halıcıoğlu ve Taşğın, 2013). Since new questions could appear in the course of the interview process, the semi-structured interview was done.

A draft interview form was prepared and it was presented to a domain expert. The questions to be asked in the interview took the final form in line with the views and suggestions of the expert. The questions are as follows:

1. When you realize your students did not understand the problem after reading it, how did you act?
2. When your students told you there was no information to solve the problem, how did you respond?
3. Which mathematical subjects and calculations did your students prefer more frequently?
4. How did you respond when your students asked which subjects or calculations they should use to solve the problem?
5. How did you treat when your students asked for help in calculating?
6. Did you warn your students reaching unreasonable or inappropriate results in a real life context? How did you warn them?
7. Did you encourage your students to enable them to validate their solutions? How?
8. Do you think whether your students' cognitive modelling competencies are developed or not? Please explain.
9. In which cognitive modelling competency did the maximum development occur? Please explain.
10. In which cognitive modelling competency did the most problems occur? Please explain.
11. Please compare the last year's Mathematics Applications lesson with this year's.
12. Do you think that you will use modelling problems in the upcoming years? Please explain the reasons.
13. If you have a chance to turn back, what would you change in the implementation process?

Data Analyzing

Before starting the data analysis, the video records of the interview were transcribed literally. It was observed that the teacher's answers could be gathered under certain categories and then the content analysis was utilized to organize those categories. Content analysis is a research technique for making replicable and valid inferences from texts to the contexts of their use (Krippendorff, 1980). The answers of the teacher were examined by each researcher separately. They determined basic codes individually and then came together and compared them. After comparisons, the inter-coder reliability formula (Miles & Huberman, 1994) was used and the reliability was calculated as 87,5%. So, it was understood the reliability was demonstrated. When reaching the consensus, the codes' names were reviewed and they were gathered under certain themes by comparing them constantly. The codes which were formed in this study and the themes connected to these codes were given in Table 1.

While presenting the findings of the study, the quotations were included and triple dot (…) was used to show that irrelevant speech was omitted.

Findings

As a result of the teacher's views, seven themes were determined as *Providing the development of each cognitive modelling competency*, *Development of cognitive modelling competencies*, *Factors contributing the development of the cognitive modelling competencies*, *Factors preventing the development of the cognitive modelling competencies*, *Implementation process*, *Future implementations* and *Factors required to be fixed in implementation process*. The first of the so-called themes included the teacher actions considering providing the development of each cognitive modelling competency. The relevant actions were gathered under ten codes as suggesting rereading the problem, emphasizing the mistakes, suggesting explaining the problem by someone in group, promoting in-group discussion, leading to realistic thinking, suggesting measuring objects, emphasizing to make reasonable assumptions, questioning, leading to make reasoning and giving examples from real life (see in Table 1). While the teacher expressing her thoughts about providing the development of understanding the problem competency, used different strategies as suggesting her students to reread the problem, emphasizing the mistakes and explain the problem to each other.

Researcher	*When you realize your students did not understand the problem after reading it, how did you act?*
Teacher	*I told them to reread the problem. I emphasized their mistakes if any. I asked them to explain the problem to each other.*

The teacher led the students to realistic thinking, suggested measuring objects and emphasizing to make reasonable assumptions to enable the development of simplifying competency.

Researcher	*When your students told you there was no information to solve the problem, how did you respond?*
Teacher	*The problems were generally from the real life. I told them to think about the problem reasonably. … I told them to carry out measurements in some problems. They started to measure each other's arms, foots, etc. They started to measure floor tiles. They regarded to perform measurements about the problem. … Then they tried to make reasonable assumptions.*

Before asking the teacher what her thoughts were regarding the development of the competencies of mathematizing and working mathematically, it was tried to reveal previously which mathematical subject the students used. After that, she explained that they should arrived decisions into their groups and led them to make reasoning and questioning when they asked her help about which mathematical subjects they should use or how they should make calculations.

Researcher	*Which mathematical subjects and calculations did your students prefer more frequently?*
Teacher	*Addition, subtraction, multiplication and division. Afterwards they started to use ratio and proportion. They already didn't know any other subjects. They utilized everything they knew. …. The subjects they have learned up to now are about four operations. So they think that they solved every problem by using four operations. They already did.*
Researcher	*How did you respond when your students asked which subjects or calculations they should use to solve the problem?*
Teacher	*I let them alone. I told them arriving decisions by discussing in their groups. If I had great difficulty, I tried to guide them by asking questions.*
Researcher	*How did you treat when your students asked for help in calculating?*
Teacher	*I told them again they should solve problem in their groups. I led them by asking questions if needed. But I avoided from giving answers directly in general. I tried to provide them to find answers by themselves.*

When examining the teacher's views about the development of the interpreting competency, it was seen she preferred to make the students to question the reasonableness of solutions and asked questions to them.

Researcher	*Did you warn your students reaching unreasonable or inappropriate results in a real life context? How did you warn them?*

Teacher	*When I examined their solutions, I asked them whether the solutions were reasonable or not. For example, Blue Team [one of the groups] insisted on one of their solutions although they reached an unreasonable result about the area of the kitchen. Moreover Fikirmatik [another group] wanted that they considered the man's height as a dwarf's height. They took a man's height as 30 cm or something else. Apart from these, one of the groups considered approximate woman height as 160 cm, other group took it as 180 cm in the Straw Bale problem. I asked them to question whether an approximate woman's height could be 180 cm or not. I asked them whether it was reasonable or not.*

She expressed that she tried to make her students to question the appropriateness of the solutions, she asked questions and gave examples from real life to enable the validation of solutions.

Researcher	*Did you encourage your students to enable them to validate their solutions? How?*
Teacher	*I only asked them whether they were reasonable or not. Is there a person in this height in your opinion? Is there a kitchen like that in your opinion? Do you live in a mansion? I asked questions like that.*

When the views were examined in the context of the second theme named *Development of cognitive modelling competencies*, two codes were identified as general ideas and individual development (see in Table 1). Under the code of general ideas, the teacher expressed most groups' cognitive modelling competencies were developed and interpreted this development in general terms. While she stated the students developed their mathematizing, working mathematically and simplifying competencies mostly, they had difficulties in interpreting and validating.

Researcher	*Do you think whether your students' cognitive modelling competencies are developed or not? Please explain.*
Teacher	*Surely they developed. Not all of them but most of them. … Our students generally follow a path like that: They read the problem, they immediately started to calculate something without understanding or interpreting the problem or thinking on givens and goals or simplifying. They used multiplication, subtraction, multiplication, division and used numerical values given in the problem accidentally. But in the implementation, they tried to understand the problem afterwards. They started to discuss what they should do. In this sense, this [implementation] has become very useful aimed at reading comprehension. There was a huge development in making assumptions. Some of them tried to question whether their solution was reasonable or not in the interpretation stage.*
Researcher	*In which cognitive modelling competency did the maximum development occur? Please explain.*
Teacher	*I think, mathematizing. … Also working mathematically. In addition, their solutions were developed quietly. … They initially had difficulties in making assumptions in simplifying. Because making assumptions is really unusual situation for them. Then […] they started to make assumptions appropriate to the problem.*
Researcher	*In which cognitive modelling competency did the most problems occur? Please explain.*
Teacher	*In the last competencies, they had troubles in interpreting and validating. Much time was needed to pass for them to display approaches in the context of interpreting and validating. In the last implementations, they respectively interpreted and validated the solutions.*

The teacher also mentioned individual development under the code of general ideas and stated even the low-achievement and lazy students made progress.

Teacher	*… There is also individual progress. For example İlker from Blue Team or some pupils from Brainboxes. Erdem told me that his mathematics grade raised during this implementation. I mean, there is a significant progress individually and as a group. I think group working is really affective in this process. … Our 6th graders' achievement is not much. I had troubles with some of the students last year and I told them not to select the lesson this year. For example, I didn't want Kayra to come the lesson. But I can say now, he selected the lesson fortunately. He made a huge progress. Also I told Batuhan not to select but he made a huge progress too. They surprised me.*

There appeared four codes as increasing the variable number, recognizing modelling process, considering real life and having experience in modelling under the third theme named *Factors contributing the development of cognitive modelling competencies* (see in Table 1).

Teacher	*Their initial models were extremely simple. They started to construct models by considering more variables in the last implementations. They became professional. … There is progress in solutions too. … They had difficulties initially. Then they understand how to solve modelling problems due to our guidance. They especially solved problems better after we told them the stages of the modelling process and asked them to solve the problems according to the stages. They made progress to some extent until that time then they advanced much more. … They understood how to make assumptions and made assumptions more appropriate to the real life and problem situation.*

The teacher stated her thoughts as not considering the solution in real life context, not checking the calculations, willing to reach the result as soon as possible and thinking that the solution process is completed when reaching the numerical result under four codes in the frame of the *Factors preventing the development of cognitive modelling competencies* in other words fourth theme (see in Table 1).

Teacher	*They had not investigated what the results meant. Because there was no interpretation, they hadn't already validated the results. In the simplest term, they didn't control their calculations initially. They thought that the process was over when they reached any numerical value. After that, when we asked them to question what their solutions meant especially in the last implementations, they checked the solutions' reasonableness and accuracy. Then there happened quite change.*

When she compared the implementation with the previous year's Mathematics Applications lesson, she expressed their thoughts under four codes as making a contribution to professional development, using appropriate problems for students, considering appropriateness to real life and motivating students in the context of the theme named *Implementation process* (see in Table 1).

Researcher	*Please compare the last year's Mathematics Applications lesson with this year's.*
Teacher	*… This study made a significant contribution to my professional development. The pupils were more active this year. I wasn't pleased with the book of Mathematics Applications lesson last year. These problems implemented in the study were more advisable and suitable for the students. … The problems were examples of the ones which were more understandable by the students and concretize mathematics. In this sense, it [this year's] was better and more beautiful. … We distributed papers on which the problems from textbook were written to the students last year and gave them one-lesson duration to solve them. In the second lesson, we solved the problems as teachers. There were really though problems in the book. None of the children was volunteered to solve the problem on the board. They were only 5th graders and just knew addition in natural numbers. We called them to the board and asked them to decide which fuel was more profitable. But they required knowing ratio and proportion and 5th graders hadn't learned it yet. This implementation was more effective in this sense.*

The theme named *Future Implementations* were comprised of four codes as considering classroom size, using tasks appropriate to student level, preferring individual work and using mathematical modelling in also mathematics lesson (see in Table 1). When examined the teacher's views regarding the usage of mathematical modelling in next years' Mathematics Applications lesson, it was seen that she expressed she could realize implementations providing that the classroom size was less, she chose tasks appropriate to the student level and she preferred individual implementations instead of group work. Moreover she stated she would spare time for mathematical modelling in mathematics lessons as well as Mathematics Applications.

Researcher	*Do you think that you will use modelling problems in the upcoming years? Please explain.*
Teacher	*If there are fewer students in Mathematics Applications, I will implement modelling problems on my own easily. I'm sure it will be useful. But if there is too crowded class, I will be unable to carry through. I think we overcame lots of difficulties because we worked together. Because there were fighting students, misbehaving children, being cross for a while with his group member or the students who didn't want to solve the problem. We were obliged to cope with different problems week by week. If there is a crowded class in the future, I can ignore others while tackling with the groups having problems. Now I am trying to prepare a plan because I will teach 5th graders in the next year. I'm planning to implement modelling problems in 5th graders both in Mathematics Applications and mathematics lessons. I'm thinking on which problems I will implement. I will definitely implement modelling but this implementation may not be as a group work. It will be individual.*

Finally the theme named *Factors required to be fixed in the implementation process* was comprised of four codes as predetermining classroom rules, planning seating arrangement, having more time for solution presentations and having time for discussing solutions after presentations (see in Table 1). The teacher told that she would firstly determine the classroom rules, change the seating arrangement, enable the students to be more active in presentations of solutions and support them to revise their solutions after presentations.

Researcher	*If you have a chance to turn back, what would you change in the implementation process?*
Teacher	*Firstly, I would determine the classroom rules from the beginning. I would arrange the classroom as U-type enabling the center of the classroom will be empty. There is need to organize the presentations. We could spare too little time to presentations. The presentations were done in a hurry and so they could not present their solutions effectively. In addition, I would spare nearly 5 minutes for them to discuss solutions and to revise if needed.*

Discussion and Results

The certain strategies are used by the teacher in this study aiming at revealing the views regarding the development of the students' cognitive modelling competencies and the implementation process. It was seen that she dwelled on the general strategies by suggesting rereading the problem, emphasizing the students' mistakes, promoting in-group discussion, questioning and leading to make reasoning to enable the development of the cognitive modelling competencies. Besides, she emphasized the relationship between mathematical modelling and real life by using the strategies such as leading them to realistic thinking, suggesting measuring the objects in the class and giving examples from real life. Blum and Borromeo Ferri (2009) and Kaiser, Schwarz and Tiedemann (2010) indicate that students can have difficulties in modelling and cannot display suitable modelling behaviors because of the connection between mathematical modelling and real life. In this context, the so-called strategies both prevented the difficulties originated from real life and provided the development of cognitive modelling competencies. The students simplifying the problem in the modelling process are required to make realistic assumptions and these assumptions affect the modelling process directly (Borromeo Ferri, 2006). For the teacher to encourage the students in making realistic and reasonable assumptions was related to the development of the simplifying competency and also ensured that the students succeeded in the whole modelling process. When the views were regarded in general, she emphasized the existence of the development of cognitive modelling competencies.

The fact that the students constructed mathematical models including the more variables and considered the real life more were the leading among the factors contributing the development of the cognitive modelling competencies. In addition, the teacher stated that the students could contribute their cognitive modelling competencies because of having experienced in the modelling process. The relevant finding showed parallelism with the judgement of the fact that the modelling experience had positive impact on the development of the cognitive modelling competencies (Biccard, 2010; Ji, 2012; Kaiser & Maaß, 2007; Maaß, 2006). The introduction of modelling process during the implementation influenced positively the so-called development. Similarly, Kaiser and Maaß (2007), Maaß (2006), and Kaiser, Schwarz and Tiedemann (2010) indicate that the knowledge on modelling process supports the development of the cognitive modelling competencies. The teacher explained that for the students not to consider the numerical solutions in the context of real life, not to check the calculations, to tend to finish the solution process immediately and to think the solution process was over when they reached the numerical result influenced the competency development negatively. But the statements were regarding the initial implementation and those factors were removed in the end of the implementations.

When considered the views about the implementation process, she indicated that the implementation process contributed her professional development, the problems appropriate to the students' interest and levels were used during the implementation, real life was considered and the implementation motivated the students. In addition, providing that the classroom size would be less, she stated that she would continue to perform modelling implementation and in this process she remarked to prefer the problems appropriate to the student level and prioritizing the individual work. She also explained that she would utilize modelling problems in regular mathematics lessons as well as Mathematics Applications. Some factors needed to be fixed according to the teachers' experiences in the implementation came to the forefront. She indicated that predetermining the class rules in an attempt to prevent possible indiscipline, changing the classroom arrangement, sparing more time for group presentations after solution process and discussing the solutions after presentations were the factors to be revised.

It is thought that the strategies used by the teacher to provide the development of the cognitive modelling competencies can be varied through different implementations and the studies discussing especially those strategies can be conducted. It is suggested for researchers and teachers to design the modelling implementations effectively by using the emerged factors in the study and the new factors to be gained in the future studies.

References

Biccard, P. (2010). An investigation into the development of mathematical modelling competencies of Grade 7 learners. Unpublished Masters Dissertation, Stellenbosch University.

Blomhøj, M. & Højgaard Jensen, T. (2010). What's all the Fuss about Competencies? In W. Blum, P. L. Galbraith, H. W. Henn, & M. Niss (Eds.), Modelling and Applications in Mathematics Education: The 14th ICMI Study (pp 45-56). Springer: New York.

Blum, W. & Leiß, D. (2007). How Do Students and Teachers Deal With Modelling Problems? In C. Haines, P. Galbraith, W. Blum & S. Khan (Eds.), Mathematical Modelling (ICTMA 12): Education, Engineering and Economics (pp. 222-231). Chichester: Hollywood.

Blum, W., & Borromeo Ferri, R. (2009). Mathematical Modelling: Can It Be Thought or Learned?. Journal Of Mathematical Modelling And Application, 1(1), 45-58.

Borromeo Ferri, R. (2006). Theoretical and Empirical Differentiations of Phases in the Modelling Process. Zentralblatt für Didaktik der Mathematik-ZDM, 38 (2), 86-95.

Bracke, M. & Geiger, A. (2011). Real-World Modelling in Regular Lessons: A Long-Term Experiment. . In G. Kaiser, W. Blum, R. Borromeo Ferri, & G. Stillman (Eds.), Trends in Teaching and Learning of Mathematical Modelling. International Perspectives on the Teaching and Learning of Mathematical Modelling (pp. 529-549). New York: Springer.

Çepni, S. (2009). Araştırma ve Proje Çalışmalarına Giriş. Trabzon.

Chan, C. M. E. & Foong, P. Y. (2013). A Conceptual Framework for Investigating Pupils' Model Development during the Mathematical Modelling Process. The Mathematics Educator, 13 (1), 1-29.

Chan, C. M. E. (2010). Tracing Primary 6 Students' Model Development Within the Mathematical Modelling Process. Journal of Mathematical Modelling and Applications, 1(3), 40-57.

Grünewald, S. (2012). Acquirement of Modelling Competencies – First Results of an Empirical Comparison of the Efectiveness of a Holistic Respectively an Atomistic Approach to the Development of (Metacognitive) Modelling Competencies of Students. 12th International Congress on Mathematical Education, 8 July-15 July 2012, COEX, Seoul, Korea.

Grünewald, S. (2013). The Development of Modelling Competencies by Year 9 Students: Effects of a Modelling Project. In G. A. Stillman, G. Kaiser, W. Blum, & J. P. Brown (Eds.), Teaching Mathematical Modelling: Connecting to Research and Practice. International Perspectives on the Teaching and Learning of Mathematical Modelling (pp. 185-194). New York: Springer.

Güler, A., Halıcıoğlu, M. B. & Taşğın, S. (2013). Sosyal Bilimlerde Nitel Araştırma Yöntemleri. Ankara: Seçkin Yayıncılık.

Işık, A. & Mercan, E. (2015). Ortaokul Matematik Öğretmenlerinin Model ve Modelleme Hakkındaki Görüşlerinin İncelenmesi. Kastamonu Üniversitesi Kastamonu Eğitim Dergisi, 23 (4), 1835-1850. Ji, 2012

Kaiser, G. & Maaß, K. (2007). Modelling in Lower Secondary Mathematics Classroom – Problems and Opportunities. In W. Blum, P. L. Galbraith, H. W. Henn, & M. Niss (Eds.), Modelling and Applications in Mathematics Education: The 14th ICMI Study (pp 99-108). Springer: New York.

Kaiser, G., Schwarz, B. & Tiedemann, S. (2010). Future Teachers' Professional Knowledge on Modeling. In R. Lesh, P. L. Galbraith, C. R. Haines, & A. Hurford (Eds.), Modeling Students' Mathematical Modeling Competencies (pp. 433-444). New York: Springer.

Krippendorff, K. (1980). Content Analysis: An Introduction to its Methodology. Beverly Hills, CA: Sage Publications.

Maaß, K. (2005). Barriers and Opportunities fort he Integration of Modelling in Mathematics Classes: Results of an Empirical Study. Teaching Mathematics and Its Applications. 24 (2-3), 61-74.

Maaß, K. (2006). What are Modelling Competencies?. Zentralblatt für Didaktik der Mathematik-ZDM. 38 (2), 113-142.

Merriam, S. B. (2013). Nitel Araştırma Desen ve Uygulama İçin Bir Rehber. (S. Turan, Çev.) Ankara: NOBEL.

Miles, M. B., & Huberman, M. A. (1994). Qualitative Analysis: An Expanded Sourcebook. Thousand Oaks, CA: Sage.

Özdemir, G. & Işık, A. (2015). Katı Cisimlerin Alan ve Hacimlerinin Matematiksel Model ve Matematiksel Modelleme Yöntemiyle Öğretimine Yönelik Öğretmen Görüşleri. Kastamonu Üniversitesi Kastamonu Eğitim Dergisi, 23 (3), 1251-1276.

Tekin Dede, A. & Bukova Güzel, E. (2013). Matematik Öğretmenlerinin Model Oluşturma Etkinliği Tasarım Süreçleri ve Etkinliklere Yönelik Görüşleri. Bartın Üniversitesi Eğitim Fakültesi Dergisi, 2, 1, 300-322.

Tekin, A., Hıdıroğlu, Ç. N., Kula, S., Bukova Güzel, E. & Uğurel, I. (2012). Determining the views of mathematics student teachers related to mathematical modeling. International Journal for Mathematics Teaching and Learning, 3.

Table 1. The themes and codes

Theme 1: Providing the development of each cognitive modelling competency	
	Code 1.1: Suggesting rereading the problem
	Code 1.2: Emphasizing the mistakes
	Code 1.3: Suggesting explaining the problem by someone in group
	Code 1.4: Promoting in-group discussion
	Code 1.5: Leading to realistic thinking
	Code 1.6: Suggesting measuring objects
	Code 1.7: Emphasizing to make reasonable assumptions
	Code 1.8: Questioning
	Code 1.9: Leading to make reasoning
	Code 1.10: Giving examples from real life
Theme 2: Development of cognitive modelling competencies	
	Code 2.1: General ideas
	Code 2.2: Individual development
Theme 3: Factors contributing the development of cognitive modelling competencies	
	Code 3.1: Increasing the variable number
	Code 3.2: Recognizing modelling process
	Code 3.3: Considering real life
	Code 3.4: Having experience in modelling
Theme 4: Factors preventing the development of cognitive modelling competencies	
	Code 4.1: Not considering the solution in real life context
	Code 4.2: Not checking the calculations
	Code 4.3: Willing to reach the result as soon as possible
	Code 4.4: Thinking that the solution process is completed when reaching the numerical result
Theme 5: Implementation process	
	Code 5.1: Making a contribution to professional development
	Code 5.2: Using appropriate problems for students
	Code 5.3: Considering appropriateness to real life
	Code 5.4: Motivating students
Theme 6: Future implementations	
	Code 6.1: Considering classroom size
	Code 6.2: Using tasks appropriate to student level
	Code 6.3: Preferring individual
	Code 6.4: Using mathematical modelling in also mathematics lesson
Theme 7: Factors required to be fixed in the implementation process	
	Code 7.1: Predetermining classroom rules
	Code 7.2: Planning seating arrangement
	Code 7.3: Having more time for solution presentations
	Code 7.4: Having time for discussing solutions after presentations