Journal for the Education of Gifted Young Scientists, 11(4), 529-539, Dec 2023
e-ISSN: 2149- 360X
jegys.org
dergipark.org.tr/jegys

Young Wise Publishing
youngwisepub.com
gencbilgeyayincilik.com

Research Article

Mathematics teachers' perspectives on the use of math teaching materials

Bilge Yılmaz Aslan[1]

Department of Mathematics and Science Education, Faculty of Education, The University of Gaziantep, Gaziantep, Turkiye

Article Info

Received: 10 October 2023
Accepted: 15 December 2023
Available online: 30 Dec 2023

Keywords
Mathematic education
Math teaching materials
Mathematics teachers
Teacher perspectives

Abstract

The aim of this study is to reveal the perspectives of secondary school mathematics teachers about the use of materials in mathematics teaching. For this purpose, the teachers' use of materials, the materials they have used, and their views on the role of using materials were analysed. In this context, the research was conducted with case study, one of the qualitative research designs. In accordance with the purpose of the research, easily accessible case sampling method was used to form the study group. The data of the study were collected from eight secondary school mathematics teachers working in different schools on a voluntary basis with a semi-structured interview form consisting of three open-ended questions about the use of materials in mathematics teaching. The interviews were audio recorded and the dialogues were transcribed. The data obtained were analysed by content analysis method. As a result of the study, it was determined that teachers' perspectives on the use of materials were built on four themes: the role of purpose of use, the role of effect on teaching, the role of effect on students and the materials used. Regarding the purpose of using the material, it was determined that most of the teachers emphasised the role of attracting attention to the lesson, the role of concretisation as the effect on teaching, and the role of facilitating understanding and remembering as the effect on students. Although the teachers stated that the use of materials had a positive effect, it was concluded that their use in the application dimension was at a low level. Another striking result of the study was that the concrete materials that some teachers stated that they used were actually course materials. When the focus was on what they used as materials, it was determined that all of the examples given were concrete materials actively used in the geometry learning domain. In addition, only one of the eight teachers participating in the study mentioned virtual learning objects (manipulatives) other than concrete materials as materials.

To cite this article:

Yılmaz Aslan, B. (2023). Mathematics teachers' perspectives on the use of math teaching materials. *Journal for the Education of Gifted Young Scientists*, *11*(4), 529-539. DOI: http://dx.doi.org/10.17478/jegys.1373687

Introduction

As in every branch, there are updates in mathematics and mathematics teaching. One of the current updates is the teaching of the abstract structure of mathematics by concretising and visualising teaching (Öksüz & Uça, 2011; Baki, 2002). While explaining the approaches of mathematics teaching programmes, it is stated that they are based on the active participation of students in the process of doing mathematics and that students in this age group will form their own ideas from their interactions with their environment, concrete objects and peers (Kutluca & Akın, 2013). As Ergin (1995) stated, when it is considered that appealing to more senses results in more permanent learning, the use of materials in teaching has positive effects and provides permanent learning (Çelik, 2007). In this framework, the use of materials

[1] Research Assistant, Dr., Department of Mathematics and Science Education, Faculty of Education, The University of Gaziantep, Gaziantep, Turkiye. E-mail: bilqe.yilmaz@gmail.com ORCID:0000-0001-8632-4775

has become an important tool especially in primary and secondary school mathematics teaching (Bozkurt & Polat, 2011; Bozkurt & Akalın, 2010). The role of material use in mathematics lessons has made it inevitable to carry out many concrete material-oriented studies. For example, in a study on the use of concrete materials, Kelly (2006) concluded that the use of concrete materials in mathematics teaching contributed positively to students' learning and problem solving skills at primary school level. In a study (Kıyıcı, Erdoğmuş, & Sevinç, 2007), which examined the opinions of pre-service teachers about the contribution of using concrete materials in the classroom environment to teaching, it was concluded that the use of materials facilitates learning and improves psychomotor skills.

In the study conducted by Domino in 2010 with meta-analysis method, it was compared whether teaching with concrete materials and teaching with traditional method made a difference in terms of students' mathematics achievement. As a result of the research, it was concluded that the use of concrete materials in students from kindergarten to 6th grade level increased student achievement.

Dokur (2013) examined the effect of using concrete materials and Geometer's Sketchpad supported applications on the achievement and mathematical explanations of prospective mathematics teachers. In this quasi-experimental study, he concluded that the students who were taught with technology-supported applications made more convincing explanations for mathematical problems. Kadagöl (2018) examined the effect of using materials in mathematics lesson on the mathematical skills of 8th grade students. As a result, it was concluded that the use of materials in mathematics lessons contributed positively to students' mathematical skills.

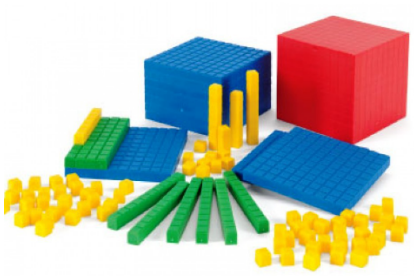
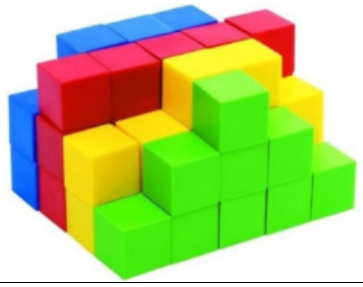
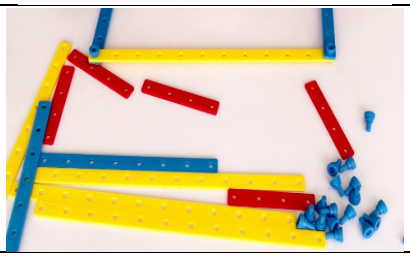
When the studies given above are examined, many studies have been conducted on the effect of material use on student achievement, its effect on teaching, and its effect on student beliefs and attitudes. In addition, it is seen that there are also studies on the attitudes of pre-service teachers and teachers towards the use of materials. Although the use of materials contributes so much to the effectiveness of teaching, there are some problems regarding the use of materials in mathematics teaching. Although researchers state that this situation is caused by many reasons, teachers' knowledge, attitudes and beliefs on this issue are important factors (Stein & Bovalino, 2001). Therefore, the views of teachers, who are responsible for the design and structuring of instruction, on the use of materials are a matter of curiosity. The problem statement of the research is "What are the perspectives of secondary school mathematics teachers on the use of materials in classroom teaching practices?".

Materials used in mathematics teaching

Materials designed to represent abstract mathematical concepts and used in classroom mathematics teaching lessons are fixed or movable objects that activate more than one sense organ of students (Bozkurt & Akalın, 2010). The materials can be base ten blocks, fraction cards, counting stamps, geometry boards or computer software (virtual manipulatives).

Tangible materials provide students with a practical learning opportunity during teaching based on the feature of appealing to multiple senses of students (Moyer, 2001). With this definition of tangible materials, the necessity of using tangible materials in teaching is understood, especially when the characteristics of students at primary and secondary school level are examined. As a matter of fact, Clements and McMillen (1996) emphasised that elementary school students learn mathematical abstract concepts and information more meaningfully in a learning environment represented by concrete models. Examples of concrete materials whose effectiveness in terms of teacher and student in mathematics teaching has been demonstrated by various studies are shown in Table 1.

Table 1. Some examples of concrete materials used in mathematics teaching and their usage areas

Examples of concrete materials	Area of use	Visual	
Base blocks of tens	It is used to model comparing, ordering, adding, subtracting, multiplying and dividing decimal fractions. This material is used to present the hierarchy of numbers (one, ten, hundred, thousand) in geometric form.		Web 1
Unit cubes	Used in area and volume calculations and to express spatial relationships		Web 2
Geometry board	Geometric shapes such as triangles, squares and circles can be made with tyres on the geometry board. It is used to find a closed area formed on the geometry board by dividing it into shapes whose areas we can simply calculate.		Web 3
Pattern blocks	Pattern blocks are used for creating patterns, establishing perimeter and area relationships and symmetry.		Web 4
Fraction bars	Fraction bars are used for teaching, comparing and ordering fractions.		Web 5
Geometry strips	It is used to construct different geometric shapes. It helps to see the properties of the shapes created with strips of different lengths and the relationships between them.		Web 6

In addition to the use of concrete materials in mathematics teaching, there are also studies on the use and effect of virtual manipulatives as materials. When Moyer, Bolyard, and Spikell (2002) first defined virtual manipulatives, they referred to them as web-based interactive learning tools that can be moved with a computer mouse. With the advances in technology, virtual manipulatives are operated with devices such as tablet computers and smartphones in addition to computers (Moyer-Packenham & Bolyard, 2016). Virtual manipulatives, which are 2D or 3D digital versions of concrete materials, are developed as web-based or application (Bouck & Flanagan, 2010). Some virtual manipulatives used in mathematics teaching are shown in Table 2.

Table 2. Examples of virtual manipulatives and their websites

Virtual manipulatives	**Web sites**
National Library of Virtual Manipulatives	Web 7
Illuminations from the National Council of Teachers of Mathematics	Web 8
MathTools	Web 9
The Math Learning Center	Web 10

Importance of research

All activities that can be done to teach the content of a teaching are carried out in the learning-teaching process dimension of the education programme (Demirel, 2007, 44). Questions such as what kind of learning activities will be done, when, where, how, how long and by whom they will be taught and learnt are within the scope of this dimension (Özbek, 2007, 138). One of the elements included in the learning-teaching process, which has a dynamic structure, is the materials used during teaching. Karakırık and Aydın (2011) put forward the idea that the ideas about the use of materials in the learning-teaching process have an effect on the quality of the process with the statement "The use of an educational tool without determining its place in the learning-teaching process is not sufficient to increase the quality of the learning process (page 20)."

It is thought that determining what kind of materials teachers prefer for what purposes and their perspectives on materials will gain importance in terms of the design of learning environments to be formed during classroom teaching practices. For this reason, it is important to determine teachers' perspectives on the use of materials in teaching. It is thought that the results obtained at the end of the research will contribute to the literature to know what the ideas brought to the forefront in the teachers' perspectives on the use of materials, what their perceptions of the concept of materials are, and which materials are primarily evoked in their minds when it comes to the use of materials.

Research Problem

The aim of this study is to determine the perspectives of secondary school mathematics teachers towards the use of materials in mathematics lessons. In line with this purpose, answers to the following questions will be searched.

- Which materials do secondary school mathematics teachers use in their mathematics lessons?
- What are the views of secondary school mathematics teachers on the role of using materials in mathematics lessons?

Method

Research Model

In this study, which was conducted to reveal the perspectives of secondary school mathematics teachers on the use of materials in mathematics lessons, a case study from qualitative research methods was adopted. Qualitative research method is a research method carried out with the participation of a limited number of people to understand the reasons for human behaviours and thoughts on any subject (Patton, 2014; Yıldırım & Şimşek, 2011). Bernat and Gvozdenko (2005) emphasise that the case study is qualitative in nature and contributes to an interpretive paradigm and states that it is a research approach that facilitates the exploration of a phenomenon in its own context by using various data sources (Baxter & Jack, 2008). Therefore, case study is considered to be an appropriate approach for the purpose of the research.

Study Group

The study group consisted of eight mathematics teachers working in public secondary schools affiliated to the Ministry of National Education (MoNE) in a city in the Southeastern Anatolia region. Each teacher was given a code and they were represented with these codes in the presentation of the findings. Information about the participants and their codes are presented in Table 3.

Table 3. Structures and coding of the mathematics teachers participating in the study

Participant No	Gender	Seniority	Teaching class	Codes
P1	F	1-5 years	5th grade	P1-F
P2	M	16 years +	7th grade	P2-M
P3	M	16 years +	8th grade	P3-M
P4	F	1-5 years	6th grade	P4-F
P5	M	6-15 years	7th grade	P5-M
P6	M	1-5 years	7th grade	P6-M
P7	F	6-15 years	5th grade	P7-F
P8	M	16 years +	8th grade	P8-M

When Table 3 is analysed, it is seen that the participant group provided diversity in terms of the grade level, professional experience and gender.

Data collection process and analysis

Semi-structured interviews were conducted with a total of eight teachers. In the interview form, questions about the participants' use of materials in mathematics teaching, the materials they used, and the purpose of using materials were included. These questions were as follows;

- Do you use materials in your lessons? Explain.
- What are the materials you use? Explain.
- For what purpose and how do you use these materials? Explain.

It was paid attention that the questions in the interview form were understandable, open-ended and flexible. After the interview form was prepared, the opinions of two field experts were consulted and necessary arrangements were made. The interviews were conducted face-to-face according to the available time of the teachers. The interviews with the participants were recorded with permission. Content analysis was used to analyse the data obtained from the interviews.

Firstly, the participant responses were converted into a text file in computer environment without any changes by the researcher. In the file created, the answers given for each open-ended question in the interview form were listed and created descriptively. As a result of the creation of the whole file, the texts were read independently by both the researcher and the mathematics education specialist, and possible themes and codes were created. The independently created themes and codes were compared and finalised. The data obtained were categorised under four themes in total. In order to ensure the reliability of the research, the field expert was asked to match the codes with the themes. The matching made by the researcher was compared with the matching made by the field expert. Miles and Huberman's (1994) formula was used to calculate the percentage of agreement. Accordingly, the agreement was calculated as 92%. In addition, while interpreting the themes obtained from the data, direct quotations were included to ensure reliability and validity. Then, the codes belonging to the determined themes were presented in tables as frequency values and sample quotations.

Ethics

A wet signed form was obtained from the teachers in the study group indicating that they participated voluntarily.

Results

It was determined that secondary school mathematics teachers' perspectives on the use of materials were built on four themes: materials used , purpose of use, effect on teaching, effect on students. The results of each theme will be presented separately.

Materials used

The findings of the answers given by the teachers about the materials they used in their mathematics lessons are shown in Table 7.

Table 7. Content analysis of mathematics teachers' views on the materials they use in mathematics lessons

Materials used	**f**
Concrete materials: tangram, unit cubes and geometry board	2
Technological: Virtual manipulatives,	1
Other: Pencil, paper, board, compass, ruler, square, slide, projector	8

When Table 7 is analysed, all of the teachers stated that they used compass, ruler and square as materials. It is a remarkable finding that teachers defined course materials as materials. In addition, it is another remarkable finding that only one teacher from the participant group mentioned virtual learning objects (virtual manipulatives) other than concrete materials. When we look at the concrete material examples, it is seen that all of the examples given are related to geometry learning domain.

Purpose of use

The findings regarding the role of teachers' purpose of using materials in mathematics teaching are given in Table 4.

Table 4. Content analysis of teachers' views on the purpose of using materials in mathematics teaching

Purpose of Use	**Description**	**f**	**Quote**
Retention in learning	When learnt, they are expressions in the form of keeping and remembering in their long-term memory.	2	"I use it so that the lesson will be permanent and the student will keep it in his/her long-term memory when he/she learns it." (P3-M)
Developing the ability to use	Showing how to use, teaching, showing how to create.	2	"For example, think of a protractor, I show the children how to use it, how to measure it." (P1-F) "For example, since the children have never seen a tangram, I show them how to create a shape in geometry on the geometry board to show how to use it." (P5-M)
Ease of learning	Showing the shapes more clearly, using them while solving sample problems.	1	"I use materials such as computer and projection mostly while solving examples." (P6-M)
Drawing attention to the lesson	While telling what the subject is in the introduction of the lesson, it is the expressions that it appeals to different sensory organs.	3	"I usually use that material at the beginning of the lesson to attract attention." (P8-M)
Making the subject understandable	The expressions of understanding the subject more clearly and being descriptive.	2	"I use it in the lesson to show the shapes more clearly, to make them clearer." (P4-F)

When Table 4 is analysed, it is seen that there are different roles that teachers attribute to the material in the background of using materials in their lessons. As a matter of fact, when these roles are focused on, it is seen that there are teachers who use the material in order to provide retention in learning as well as teachers who use the material only to attract students' attention to the lesson. While it can be said that the purpose of using the material of the teachers who mentioned the roles of permanence in learning and making the subject comprehensible is related to the goal of realising a meaningful learning in the presentation of the course content, it can be said that the purpose of using the material of

the teachers who mentioned the roles of developing the ability to use, ease in learning and attracting attention to the lesson is related to the goal of using it as a tool in the presentation of the course content.

Impact on teaching

The findings regarding the role of teachers' views on the effect of using materials in mathematics teaching on teaching are given in Table 5.

Table 5. Content analysis of teachers' views on the effect of using materials in mathematics teaching on teaching

Impact on Teaching	Description	f	Quatos
Explanatory role	Statements indicating that it is easier to explain to students and helps to prevent misconceptions	2	*''It is easier to explain the subject to children. There is a more detailed explanation.''(P1-F)* *“Students understand better because it is visual and there are no misconceptions.''* *(P6-M)*
Challenging role	Statements that are difficult to explain the material to the students and then to establish its relationship with the lesson.	2	*"Actually, it seems to be good, but it is a bit difficult, even the boards slip, I can't use it very well, to be honest.* *(P8-M)*
Embodiment role	Statements that are thought to be useful for explaining abstract concepts and concretising the lesson.	3	*''It makes it concrete, mathematics is already an abstract subject, but since it makes it concrete for children to understand, it is useful for teaching the subject.''* *(P3-M)* *"Some things you cannot explain verbally, but they are more easily understood and concretised visually."* *(P4-F)*
Time saving	Statements that explain more things in a shorter time.	2	*"It is useful to give more in a shorter time.* *(P6-M)* *"Since the students immediately see it themselves, it is processed more quickly, you can explain what you are going to explain in a shorter time.* *(P7-F)*

When Table 5 is examined, it is seen that the teachers mostly mentioned the role of concretisation as the effect of material use on their teaching. In addition to this, it is seen that there are those who say that it saves time in teaching, as well as those who mention the role of making it difficult because they have difficulty in using it.

Impact on the student

The findings regarding the role of teachers' views on the effect of using materials in mathematics teaching on students are given in Table 6.

Table 6. Content analysis of teachers' views on the effect of using materials in mathematics teaching on students

Impact on Students	Description	f	Alıntı
Facilitating understanding	These are the statements indicating that the students understand better and create an infrastructure in comprehending the subject.	3	*"When the child starts life, he/she will create an infrastructure, it provides permanence.(P1-F)* *"It enriches their understanding, students understand more easily. (P4-F)* *"Students learn more easily because they see it." (P7-F)*
Being interesting	These are the statements that students are more interested and enthusiastic about the lesson.	2	"Students have fun above all." (P8-M)
Enabling recall	These are the statements that it helps to make connections and mediates in making recall.	3	*""They remember more easily when they make recollections, when I ask them if they remember, they say yes, we did it in the activity and it is related to this subject".* (P5-M)

When Table 6 is analysed, when the teachers evaluated the effect of material use on students, they mostly mentioned the roles of facilitating comprehension and ensuring recall.

They also stated that it was interesting for the students and accordingly, they seemed more willing in the lesson. Apart from the above-mentioned roles regarding the effect of material use on students, there are also teachers who think that material use is not considered important for students and has no effect on students. They express that this situation is not taken into consideration by the students because it is not included in the exam system (''students do not care too much, they are not inclined, they do not dwell on it because there are no questions."P2-M)

Conclusion and Discussion

In this study, the perspectives of secondary school mathematics teachers on the use of materials in their lessons were tried to be revealed. In line with the findings, it was concluded that teachers have roles that serve different purposes in the background of using materials in mathematics teaching. Although teachers attributed different meanings to the use of materials in teaching, it was observed that they remained at a very weak level in using them in practice. It is a striking result that although teachers know that the use of materials in their lessons is theoretically important, they do not reflect it in practice. This leads to the idea that although teachers know the importance of using materials, they lack knowledge and skills in the use of materials. The use of materials in classroom teaching practices makes students active, provides richer learning opportunities, makes mathematics teaching fun and increases students' interest in the lesson. Although it is predicted that the use of materials supports teacher-student and teaching in theory, studies have shown that it does not give consistent results in practice (Özdemir, 2008). Researchers state that the knowledge, beliefs and attitudes of teachers on this subject are an important factor as one of the reasons for this result (Özdemir, 2008). As a matter of fact, when we look at the literature, there are studies on teachers' not knowing how to use the materials (Bozkurt & Şahin, 2013).

It was seen that teachers prioritised the roles of attracting attention as the purpose of using materials in mathematics lessons, providing concretisation as the effect on teaching, facilitating understanding and ensuring recall as the effect on students. When we look at the literature, it is seen that there are studies that support the research result. Tunç et al. (2011) stated that materials designed to present abstract mathematical concepts in a concrete and clear way by visualising them help students to think creatively and learn meaningfully. According to the study conducted by Gökmen, Budak, and Ertekin (2016), it is possible to say that there are similar results. As a result of the study, it was revealed that the biggest advantage of using concrete materials according to mathematics teachers is that it facilitates learning. In the same study, according to classroom teachers, the advantage of using concrete materials is that it enables learning by doing and experiencing. This is in parallel with the results of our research. When the studies in the literature are examined, it is

stated that the use of materials visualises and concretises the subject to be learnt and this makes what is learnt permanent (Clements, 2000; Thompson, Lambdin, 1994).

A striking result of the study was that although the teachers mentioned the positive role of the use of materials in mathematics lessons, there were teachers who thought that the use of materials was not considered important for students and had no effect on students. When we look at the literature, in the studies examining teachers' views on the use of materials, there are studies indicating the negative aspects of the use of materials such as taking too much time, not being able to understand mathematical concepts by students due to the difficulty of classroom control, and not having enough materials to be used (Uzundağ & Yazıcı, 2019; Yazlık, 2018; Gökmen, Budak, & Ertekin, 2016). However, here, it is considered as a finding that needs to be elaborated that the teacher's negative aspect of the use of materials is that they are not taken into consideration by the students because they are not included in the exam system.

When we look at the literature, there are studies in which no significant relationship was found between teachers' theoretical beliefs about the use of materials and their theoretical beliefs, although their theoretical beliefs and outcome expectations were high (Gökmen, Budak, & Ertekin, 2016). Since materials (concrete and/or virtual manipulatives) and lessons designed through these materials are fun and different for students, teachers believe in the necessity of using materials, but they do not use them actively due to time limitations and lack of materials.

Another striking result of this study was that what most of the teachers stated as materials were actually course materials. What they perceive and use with the concept of material are the basic tools and materials used in many subjects of mathematics course. Most of the teachers did not know the subject-specific materials and it was seen that all of the materials they mentioned as concrete materials were materials related to the field of geometry. It is thought that this situation gives a clue that teachers have the perception of matching the use of materials only with the geometry domain.

Recommendations

Recommendations for practitioners

In line with the findings obtained, it was seen that although the teachers were of the opinion that the use of materials had a positive effect on learning, they used the materials very little. For this reason, teachers can participate in in-service training seminars on the introduction and use of materials, and social networks can be provided where they can provide professional development. In addition, in order to increase the use of materials by teachers in their lessons, it can be suggested to meet the material needs of schools and to provide mathematics laboratories where they can access both concrete materials and virtual manipulatives. In addition, it is thought that teachers should make a good planning for the purpose of using the material before the lesson for the lessons in which they will use the material.

Recommendations for researchers

This study was limited to eight secondary school mathematics teachers. In future studies, the study can be quantified by applying to teachers' opinions in different regions and general results can be revealed. In addition, a scale development study can be conducted to determine teachers' competences in using materials.

A similar study can be conducted with pre-service teachers. By revealing the data about pre-service teachers' recognition and use of materials, it can be explained how they recognise the materials or where and how they use them. Thus, the perspectives of different participant groups on the use of materials can be compared and their reasons can be investigated. In addition, the knowledge and self-efficacy of teachers who know and use some materials very little can be revealed through qualitative studies.

Limitations

The research is limited to eight secondary school mathematics teachers in a province in southeastern Anatolia. In addition, the data obtained in the research are limited to the open-ended questions in the interview form.

Acknowledgment

I would like to thank the teachers who participated in the study for their contribution to the collection of research data.

Biodata of Authors

Bilge Yılmaz Aslan graduated from Gaziantep University, Department of Elementary Mathematics Teaching in 2013. She received her master's degree in 2016 and doctorate degree in 2023 at the same university. At the same time, Yılmaz Aslan was appointed as a research assistant in the Department of Mathematics and Science Education at Gaziantep University in 2015 and still continues to work as a research assistant. Fields of study: Mathematics Education - teacher educators - primary school mathematics teaching - secondary school mathematics teaching. Department of Mathematics and Science Education, Faculty of Education, The University of Gaziantep, Gaziantep, Turkey, ORCID:0000-0001-8632-4775

References

Alım, M. (2007). The importance of teaching technologies and material development course and suggestion on the teaching process. *Eastern Geographical Review*, 12(17).

Altun, M. (2006). The development in mathematics teaching. *Journal of Uludağ University Faculty of Education.* 19 (2), 223-238.

Arslan, S., & Özpınar, İ. (2009). Evaluation of 6th Grade Mathematics Textbooks Along With the Teacher Opinions. *Dicle University Journal of Ziya Gökalp Education Faculty*, (12), 97-113.

Baki, A. (2002). *Computer aided mathematics for learners and teachers*. Ankara: Ceren Publications.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The qualitative report*, *13*(4), 544-559.

Bernat, E., & Gvozdenko, I. (2005). Beliefs about Language Learning: Current Knowledge, Pedagogical Implications, and New Research Directions. *The Electronic Journal for English as a Second Language*, *9*(1)

Bouck, E. C., & Flanagan, S. M. (2010). Virtual manipulatives: What they are and how teachers can use them. *Intervention in School and Clinic*, *45*(3), 186-191.

Bozkurt, A. & Akalın, S. (2010). The importance of material development and use in mathematics education and the role of the teacher. *Dumlupınar University, Journal of Social Sciences*, 27 (1) ,54–63

Bozkurt, A. & Polat, M.(2011). Teachers' Views on the Effect of Modeling with Counters on Learning Integers, *Gaziantep University, Journal of Social Sciences* 10(2):787 -801

Bozkurt, A. & Şahin, S.(2013). Challenges in Using Materials in Elementary Mathematics Teaching and

Causes of the Challenges, *Mehmet Akif Ersoy University Journal of Education Faculty* , 25, 19 – 37

Clements, D. H. (2000). 'Concrete'manipulatives, concrete ideas. *Contemporary issues in early childhood*, *1*(1), 45-60.

Clements, D. H., & McMillen, S. (1996). Rethinking "concrete" manipulatives. *Teaching children mathematics*, *2*(5), 270-279.

Çelik, E. (2007). *The effect of using computer-aided animation in secondary school geography courses on student success.*. Master's thesis, Marmara University, İstanbul.

Dokur, N. (2013). *Investıgatıng the effects of concrete materıals and the geometer's sketchpad supported traıning on the achievement and explanations about the solutıons of mathematıcs educatıon students*. Master's thesis, Gaziantep University, Gaziantep

Domino, J. (2010). *The effects of physical manipulatives on achievement in mathematics in grades K–6: A meta-analysis*. State University of New York at Buffalo.

Ergin, A., *Instructional Technology - Communication*, (1. baskı), Ankara: Pegem Yayınları, (1995).

Gökmen, A., Budak, A., & Ertekin, E. (2016). Elementary Teachers' Beliefs About Using Manipulatives and Outcome Expectations In Teaching Mathematics. *Kastamonu Education Journal*, *24*(3), 1213-1228.

Kadagöl, E. (2018). *The effect of some material use on the rotation specifications of the 8th grade students.* Master's thesis, Osmangazi University, Eskişehir

Karakırık, E., & Aydın, E. (2011). Maths learning objects. 16th ATCM Workshop on Technology in Mathematics Education. Abant İzzet Baysal University, Bolu

Kelly, A. (2006). Composite materials after seventy years. *Journal of Materials Science*, *41*, 905-912.

Kılıç, H. &Tunç-Pekkan, Z. & Karatoprak, R. (2013). The effects of using materials on mathematical thinking skills. *Journal of Theory and Practice in Education* , 9(4), 544-556

Kıyıcı, G., Erdoğmuş, E. ve Sevinç, Ö.S. (2007). Opinions of Teacher Candidates on the Contribution of Material Use in the Classroom Environment to Education. *The 7th International Educational Technology Conference.* Near East University, North Cyprus

Kutluca, T. &Akın, F.(2013). Teaching of Mathematics with Concrete Materials: Qualitative Study on Using Four-Quadrant Algebraic Scales, *Turkish Journal of Computer and Mathematics Education*.4(1), 48-65.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook. Sage.

Moyer-Packenham, P. S., & Bolyard, J. J. (2016). Revisiting the definition of a virtual manipulative. *International perspectives on teaching and learning mathematics with virtual manipulatives*, 3-23.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. Educational Studies in mathematics, 47(2), 175-197.

Moyer, P. S., Bolyard, J. J., & Spikell, M. A. (2002). What are virtual manipulatives?. *Teaching children mathematics*, *8*(6), 372-377.

Öksüz, C., & Sanem, U. Ç. A. (2011). A Videocase in Mathematics Lesson Towards Problem Based Learning. *Adnan Menderes University Journal of Faculty of Education*, *2*(2), 20-29.

Özdemir, İ. E. Y. (2008). Prospective elementary teachers' cognitive skills on using manipulatives in teaching mathematics *Hacettepe Üniversitesi Education Faculty Journal*, *35*(35), 362-373.

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications.

Stein, M. K., & Bovalino, J. W. (2001). Reflections on practice: Manipulatives: One piece of the puzzle. *Mathematics Teaching in the Middle School*, *6*(6), 356-359.

Thompson, P. W., & Lambdin, D. (1994). Research into practice: Concrete materials and teaching for mathematical understanding. *The Arithmetic Teacher*, *41*(9), 556-558.

Tunç, M. &Durmuş, S. & Akkaya, R. (2011). Primary School Mathematics Teacher Candidates' Competencies in Using Concrete Materials and Virtual Learning Objects in Teaching Mathematics. Matematik Eğitimi Dergisi, 1(1), 13-20.

Ulusoy, K., & Gülüm, K. (2009). To use of teachers to the teaching materials while studying history and geography subjects in socıal scıence lessons. *Ahi Evran University Kırşehir Education Faculty Journal*, *10*(2), 85-99

Uzundağ, K., & Yazici, E. (2019). Elementary teachers' opinions on virtual manipulatives. *Eskişehir Osmangazi University, Journal of Social Science*, *20(1)*, 807-828.

Yazlık, D. Ö. (2018). Teachers' views on the use of concrete teaching materials in mathematics teaching. *OPUS International Journal of Society Researches*, *8*(15), 775-805.

Yıldırım, A. ve Şimşek, H. (2011). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. Ankara: Seçkin Yayıncılık.

Yıldız Tuncay, B.(2012). *A Case Study on the Use of Concrete Materials in Primary Secondary Mathematics Courses in a Private School: Teacher and Student Opinions.* Unpublished Doctoral Thesis, METU, Ankara.

Photo links

Web 1. https://www.balatoyz.com/onluk-taban-bloklari-mat011

Web 2. https://www.trendyol.com/rubenis/birim-kupleri-p-6971589

Web 3. https://www.istanbulmalzeme.com/urun/geometri-tahtasi

Web 4. https://www.youtube.com/watch?v=MpjxqTQZ6rk

Web 5. https://www.hepsiburada.com/edx-kesir-cubuklari-pm-HB00000LKDN4

Web 6. https://www.youtube.com/watch?v=8kIPNZqJBIs

Web sites

Web 7. http://nlvm.usu.edu/

Web 8. https://illuminations.nctm.org/content.aspx?id=3855

Web 9. http://www.mathforum.org/mathtools/

Web 10. https://www.mathlearningcenter.org/resources/apps