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THE EFFECT OF SUPPORTED REALISTIC MATHEMATICS EDUCATION WITH SHORT FILMS ON CONCEPTUAL AND PROCEDURAL KNOWLEDGE

Zuhal GUN SAHIN, Ramazan GURBUZ

Abstract: In Realistic Mathematics Education (RME), students should reach formal mathematics knowledge and explore mathematics based on their informal knowledge. The problems chosen in the exploration process should apply mathematics to real-life situations and be suitable for students to explore and create mathematical structures. In the current study, the researchers presented real-life problem situations with short films for getting students' attention, showing a mathematical subject in daily life, and increasing the effect of problems. In this manner, the purpose of this study was to the effects of enriched realistic mathematic education with short films on students' conceptual and procedural knowledge. Also, the researchers received participants' opinions about the teaching process. Therefore, the researchers selected 10 students as participants, who continued the 7th grade, and they examined the subject of "Equality and Equations." For collecting data in this study, the researchers used worksheets, interviews, and study journals, and they used content analysis for analyzing the data. The result of the study showed that this teaching method affected the conceptual and procedural knowledge of the students positively, and they discovered with pleasure mathematics.

Key words: Realistic Mathematics Education, short film, conceptual and procedural knowledge, teaching mathematics

1. Introduction

Mathematics is a lesson afraid by students in addition to being one of the challenging fields due to its nature. This situation affects students' mathematics achievement (Laurens et al., 2018). Students have more difficulties in some subjects in mathematics, such as algebra. Although algebra has an essential place in mathematics education, many studies have stated that students have difficulties learning algebra (Amaç and Didiş Kabar, 2019; Blanton and Kaput, 2001; Ersoy and Erbaş, 2005; Gürbüz and Akkan, 2008; Kaya, 2015). For example, Yalvaç (2010) stated that one of the subjects with the lowest success was algebraic expression (equation) based on the result of the study that was implemented by 7th-grade students.

Algebra plays a bridge role in mathematic teaching because it is a starting point for both a beginner mathematics learner and a student in higher education (Weaver, 2004). In the same way, algebra significantly guides students in thinking abstractly and making logical inferences (MacGregor and Stacey, 1996). Although the subject of equations, which plays a critical role in the transition to algebra, has a crucial in the mathematics curriculum, most of the students have difficulties in equations (Blanton and Kaput, 2001; Kaya, 2015; Vlassis and Demonty, 2000; Laughbaum, 2003).

According to Martin (2007, p. 30), mathematics failure is about the teaching method; it is not about mathematical content. For this reason, many studies have been conducted on mathematics teaching methods, and in these studies, "How can I teach mathematics effectively?" to answer the question has been tried to be sought.

The researchers worked on methods to make it easier for individuals to make sense of mathematics to create an effective teaching method. Because making sense of mathematics means seeing mathematics

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in real life, using what you learn in real life, and enjoying mathematics (Doruk and Umay, 2011). One of the reasons students have difficulty in algebra is that they consider equations a separate subject from daily life (Pope 1994).

One of the teaching methods to facilitate the mathematical interpretation process is Realistic Mathematics Education (RME). Freudenthal, the founder of this education, defined learning mathematics as an interpretation process and stated that to do real mathematics, each new stage should be based on interpretation (Altun, 2006). At the end of the process with RME, students can learn mathematics and form mathematical concepts themselves (Clements ve Sarama, 2013). Thus, the student reaches formal mathematical knowledge (Üzel, 2007). However, studies on algebra show that students have common conceptual and procedural errors and fundamental blunders in interpreting algebraic concepts (variable, inequality), constructing and solving equations, using algebraic expressions, and solving algebraic problems (Amaç and Didiş Kabar, 2019; Akkaya ve Durmuş, 2006; Kar et al., 2011; Booth, 1984, 1988; Dede and Peker, 2007; Miller and England; 1989; Kieran, 1992; Rosnick, 1981). As can be seen from studies conducted at different schools and grade levels, students have difficulties in procedural knowledge and conceptual knowledge in algebra. For this reason, the effect of teaching based on RME with short film support on conceptual and procedural knowledge was examined in the study. In the study, the subject of "Equality and Equations" has been studied.

Researchers have benefited from short films to attract students' attention, show the subject in daily life, and increase the effect of contextual problems in RME-based teaching. In the study, they also included students' views on the teaching process.

1.1. Realistic Mathematics Education and Short Film

In the process of making sense in realistic mathematics education, students create formal information based on their informal knowledge and thus discover mathematics themselves. There are some steps for this discovery process to occur. In the first step, students should be allowed to experience a similar process as mathematics was invented. Students should have the opportunity to build their math knowledge. In this step, contextual problems with various solutions should be selected (Gravemeijer, 1997). In the next step, students should find problem situations in which situation-specific approaches can be generalized (Freudenthal, 1983). In the final step, students must find the model that plays a vital role in the transition between informal and formal mathematics. A model is any situation model familiar to students (Gravemeijer, 1997).

As can be seen, contextual problems are used in the first step to inspiring the student. Contextual problems need to be well prepared and real-life contexts. Contextual problems have essential tasks. These are real-life math app, an exploration tool for math, and helping students achieve mathematical connections and transitions (Howson and Wilson 1986). The researchers benefited from short films while presenting contextual problems to the student. Yıldız and Ürey (2014) stated in their study that using films in mathematics teaching will have positive effects on students because there are many benefits of using films, which are suitable audio-visual materials, in education (Beltrán-Pellicer et al., 2018; Öztürk, 2017). Pellicer et al. (2018), while dealing with the issue of equations in their study, planned the lesson by making use of films, and as a result, reached the view that it would be appropriate to use films in teaching. In the study, the researchers took a section from real life in the short film created to construct "Equality and Equations" well in students. In the film section, they built it over two students who came across in the market and started doing mathematical operations on the scales they had seen. They presented contextual problems to the students in the classroom environment on equal arm scales. The teacher stopped the short film where necessary and enabled the students to focus on the given problems. Based on the weights and unknown weights (such as pasta, oil) placed on the scales in equal arm scales, the students tried to find the unknown weights without disturbing the balance. In this way, the researchers expected the students to make sense of equality, unknown, and equation concepts with equal arm scales and to discover the principles of solving equations with their operations on the scale. Because when students see the subject directly about daily life, their awareness will increase, and they will be able to make better sense of what they have learned (Öztürk, 2017). Therefore, they thought it would make sense to use short films in RME.

1.2. Conceptual and Procedural Knowledge

In many fields, students must learn both fundamental concepts and correct operations to solve problems. For example, mathematical competence is based on developing, interconnecting, and relating children's knowledge about concepts and operations (Hiebert and Wearne, 1986; Sumirattana et al., 2017).

- Conceptual knowledge refers to knowledge about facts, meanings, structures, ideas, principles, laws, formulas, and concepts related to mathematical issues.

-Computational knowledge refers to using mathematical procedures, languages, and symbols and how to interpret and draw graphics and tables.

However, the developmental relationships between conceptual and procedural knowledge are poorly understood (Rittle-Johnson and Alibali, 1999). According to the researchers' standard view, an increase in conceptual and procedural knowledge in one increases the other (Kadijevich, 2018), and conceptual and procedural knowledge is interdependent (Rittle-Johnson and Schneider, 2015). For an effective and meaningful mathematics education, attention should be paid to both types of knowledge (Özyıldırım Gümüş and Umay, 2017). Because conceptual and procedural knowledge is an essential structure for mathematical competence (Baroody et al., 2007).

At the end of the teaching process, the researchers discussed the conceptual and procedural information on the subject of "Equality and equations." They defined conceptual and procedural information regarding the subject in Table 1.

Table 1. *Definition of conceptual and procedural knowledge of equality and equations topics*

Category	**Definition**
Conceptual knowledge	They understand the concepts and rules about equality and equation, justifying and interpreting equation solving using different representations. They associate the concept of equality with equations. They understand the principles of solving equations. While solving, they distinguish when to do addition, subtraction, multiplication, and division on both sides of the equation, and they know why they do this operation. They know the classical definitions and meaning of equality, unknown, and equation concepts.
Procedural knowledge	They (know how to) apply definitions, formulas and operations in order to calculate the unknown expression. They are knowledgeable about representations, and algorithms. They know formulas and operations to find unknowns in different equations They know when and how to use the rules of equations.

In the study, where the researchers examined the effect of teaching equality and equations subject according to the short film supported RME learning theory on the subject's conceptual and procedural knowledge, they gave the conceptual and procedural knowledge definitions of the subject in Table 1. The researchers created the table as a result of the literature review. They considered the definitions in the table as the conceptual and procedural knowledge signs sought in students. In the study, they also examined students' views on the teaching process. The problem sentence of their work in this context is:

What is the effect of realistic mathematics teaching enriched with short films on the subject of "Equality and Equations" in middle school 7th-grade mathematics lesson on students 'conceptual and procedural knowledge, and what are the students' views on the teaching process?

Sub research problems are:

1) What is the effect of realistic mathematics teaching enriched with short films on students' conceptual and procedural knowledge?

2) What are the views of students on realistic mathematics teaching enriched with short films?

2. Method

The researchers examined the impact of RME teaching supported by short films and student views on the process. In this context, they considered the 7th-grade mathematics curriculum and created a short film on the subject of "Equality and Equations." They watched the short films to the students in the classroom and stopped them at appropriate places, so they asked them to look for answers to the short film's problems. The reasons for creating the short film are to present real-life problems that students are familiar with, which are presented to the student in the first place at RME. Based on RME principles, the researchers asked the students to start from the real-life problem in the short film, develop solutions, and try their solutions on similar problem situations they created. As a result, they expected the students to discover the steps of solving equations and form the subject's concepts.

To examine the effect in question, the researchers examined a limited number of cases in depth. Therefore, it is a case study. Yin (2009) expresses the case study as examining and describing a situation in its real context. In this study, they dealt with the case study qualitatively and used different qualitative data collection methods.

2.1. Participants

When determining the school to be studied, they chose the school where one of the researchers worked. In the school selection, they chose the participants that the researchers could easily reach, and while determining the students, they wanted to obtain rich data, so they made purposive convenience sampling. The purpose of selecting the purposeful sample is to provide the research's data richness (Neuman, 2012). As the purposeful sampling criterion is the written average of mathematics in the academic year in which the students are present. In this context, they looked at students' written scores in mathematics, and they worked with a heterogeneous group consisting of low, medium, and high levels. They chose the low-level student scores from the 0-45 range, the intermediate students from the 45-70 range, and the higher-level students from the 70-100 range. There are three low-level students in the study group, four medium-level students, and three high-level students. They provided the demographic information of the study group in Table 2.

Table 2. *Demographic information of the study group*

Student's name*	Gender (F: Female; M: Male)	Level	Class
Musab	M	high	7
Ozan	M	high	7
Batuhan	M	high	7
Kaan	M	medium	7
Senem	F	medium	7
Hilal	F	medium	7
Dilay	F	medium	7
Furkan	M	low	7
Nida	F	low	7
Hüsna	F	low	7

* Nicknames

They perform the work at the center of a province in eastern Anatolia in Turkey at a government school in the 2015- 2016 academic year. The participant class consists of 5 girls and five boys, ten students in total. While determining the subject from the 7th-grade curriculum, they chose the subject "Equality and Equations" that students had difficulty understanding. They also considered the structure of the subject and its adaptation to the short film.

2.2. Data Collection Tools

In the study, they used various inventories as data collection tools. From qualitative data, they used worksheets, study journals, and interviews. They gave the data collection steps in Table 3.

Table 3. *The data collection process of the study*

Application time	Implementation
1. Week (2 lesson hours)	They taught students about worksheets and study journals. They distributed sample study journals to the students.
1. Week (2 lesson hours)	They distributed a worksheet to the students that measured their prior knowledge of "Equality and Equations."
Weeks 1 and 2 (8 lesson hours)	he researchers had the students watch the short film they prepared. They asked the students to offer solutions to problem situations in the short film, develop solution strategies, and create similar problem situations.
2. Week (2 lesson hours)	They expected the students to adapt the solution processes they created based on the real-life situations in the short film to similar situations. They expected them to solve similar real-life problems they had set up with solution strategies.
3. Week (2 lesson hours)	At the end of the instruction, they distributed the worksheets prepared for evaluation purposes to the students. They asked questions measuring the subject-related concept and procedure knowledge.
3. Week (1 lesson hour)	They encouraged students to write study journals. Previously, the researchers gave information to the students again about what the study journals were. They found that the students had difficulty in the first place because they were writing study journals for the first time. Students finished study journals writing in 1 lesson.
	They interviewed their chosen students outside of class and talked about their responses to the worksheets. They interviewed an average of half an hour for each student. They interviewed two students in total.

As seen in the chart, the study lasted three weeks. However, they created took about one year of the preparation process for the short film. The study's application process, three weeks, was determined based on the time allocated for "Equality and Equations" in the 7th Grade Mathematics Curriculum.

2.3. Worksheet

Worksheets guide on a topic, concept, activity, or experiment. These are written and/or visual materials that can attract students' attention, reveal preliminary information, and assist teaching (Ören and Ormancı, 2012). The researchers distributed the worksheets twice, before and after the instruction. The first worksheets they distributed are to measure students' prior knowledge. The last distributed worksheet is for post-teaching students' evaluation. The researchers prepared the worksheets in the company of 3 experts. There are 14 questions in the worksheet that measures the preliminary information, and there are 23 questions in the worksheet prepared for evaluation. The worksheet they prepared for evaluation includes questions similar to the first worksheet. They formed the study from the thesis of the first researcher. All of the questions in the worksheets used in the thesis are not directed to conceptual and procedural knowledge. Researchers selected the questions regarding the thesis's conceptual and procedural knowledge and analyzed the data related to this for this study.

They formed the questions measuring the procedural knowledge based on the problems that the students were familiar with. When measuring procedural information, the accuracy of the result or the process is often checked by asking to solve a given problem. They formed the questions they prepared to measure the conceptual knowledge by determining the concepts within the subject's scope. Because, when measuring conceptual knowledge, the individual is generally asked to define and explain the related concept (Rittle-Johnson and Schneider, 2015). However, in the study, the researchers did not measure the conceptual knowledge based on only definitions because the more extensive the conceptual information measures, the more robust results (Schneider and Stern, 2010). For this reason, the researchers additionally examined the interviews they had with the students, examined the students' solutions, and looked for the conceptual signs stated in Table 1. Sample questions asked to students in the worksheets are given in Table 4.

Table 4. *Sample questions*

Category	Sample questions
Conceptual	What do you think the equation means?
Procedural	6y + 5 = 11 + 6 find the number that will replace x that satisfies the equality?

2.4. Study Journals

Teachers use the study journals to reveal students 'views on the subject or concepts in activities (Ishii, 2003). The researchers used personal study journals to determine student views on the study's mathematics subjects' teaching process. In this way, they ensured that the students could contentedly share their feelings and thoughts about the application.

They informed the students about study journals writing and the things that need attention. They stated that the study journals were different from the diaries and gave information about the study journals. They gave the students information about what the study journals were, how they were created, and what purpose they were used. They also showed the students sample study journals.

2.5. Interviews

The researchers asked questions based on the answers given by the students to the worksheets during the interviews. "Can you explain this answer a little bit?", "Can you explain the reason for giving this answer?" They asked questions such. They interviewed only two students, as data saturation was achieved in the study. While choosing these students, they made use of worksheets that measure their prior knowledge. They determined that there were no students who had prior knowledge of the chosen subject. They realized that only one student tried to solve the equations with the substitution method based on the concept of equality. While selecting the students interviewed, the student who tried to solve the equation using the substitution method and another student was randomly selected. The interview with each student lasted about half an hour.

2.6. Teaching Process

The researchers carried out the teaching process under their control. They created a short film in line with the teaching processes supported by RME and the acquisitions of "Equality and Equations" in the 7th-grade mathematics curriculum in the study. The short film featured real-life problems. They give the process of creating the short film in Table 5.

Table 5. *Creation process of the short film*

Dates	Done	Reasons for Replacement
June- October 2016	They shot the short film.	As the experts who watched did not find the sound and image quality sufficient, they made the shots again.
December january 2017	They signed with a local channel and re-shot the short films with professional crews.	Experts suggested that the short film should be shot in environments that would attract the students' attention, rather than in a monotonous environment, and they made the shootings again.
March-May 2017	They re-filmed with the necessary permissions. They searched for a natural environment for 7th graders, and after about a week, they found the appropriate environment and shot short films.	The performance of an actor who played in a short film was deemed insufficient by experts, and they re-filmed.

June July 2017	They changed the unsatisfactory actor and re-shot the short film.	They completed the shootings, and the short film they created was ready to be watched by the students in the classrooms.

As seen in Table 5, they completed the short film shooting in about one year due to the feedback and corrections. They wrote their short film on Equality and Equations over two 7th grade students who met in the market. Students in the film discovered an old-fashioned equal arm scale that the grocery store owner used to measure weights. They created real problem situations on the subject of equality and equations through an equal arm scale. They stopped short films inappropriate places and asked what the short film actors had to do to get the correct result. Later, they asked the students about the accuracy of the add-and-subtraction operations made by the players. They expected the students to create similar real-life situations based on these problems. Finally, they waited for the students to reach the concepts and rules of "Equality and Equations."

2.7. Teaching process stages

- Using and understanding real-life problems

The researchers gave the contextual problems to the students through a short film. They based the short film on children who wanted to buy balls to play in the market and realize the balance they encountered there and make balancing on the scale. In the short film, the actors put some of the ingredients from the market on one pan of the scale and the other pan's weights. One of the players asked the other what he had to do to balance the scale. The researchers then stopped the short film and asked the students what they had to do to balance the scales. The students started to do the operations to balance the scale. They made some additions or deletions on the right and left scales. The researchers prepared this section in the short film to form the concept of equality in students. Then the players put another ingredient (lşloil) from the market on one pan of the scale and added weight next to the material, just put weights on the other pan of the scale and balanced the tailor. Then they wanted to find the weight of the material (oil) put. Here the researchers posed the question to the students and asked how to find the (unknown) weight of the fat. To find the weight of the oil, the students worked on the right and left panes without disturbing the balance and found the unknown. This time, the players put the same material (pasta) in different numbers on both panes of the scale and balanced them by adding weights to the sides. They stopped the short film and asked the students to find the weight of the material put on. The students did some additions, subtractions, and divisions in the same way. The researchers thus expected the students to develop the unknown concept, the concept of equations, and the steps of solving equations. The short film continued similarly, and the short film is about 12 minutes in length.

They waited for the students to form the rules regarding the equation solving processes using the operations they made with the right and left scales. Using real-life problems that students are familiar with, they created a starting point for learning mathematics. Thus, they expected the students to understand the problems and create more meaningful learning from them. A section of the short film created by the researchers is given in Figure 1.

- Re-discovering and structuring knowledge

It is the process of building knowledge rather than transferring existing knowledge. Students participated in the process of reinventing mathematics through learning activities. With the researcher's instructions, they entered the process of mathematical exploration with the operations they made by thinking on the scale. In this process, students noticed that adding and subtracting the same amount to both panes of the scale did not disturb the balance in the scale. Thus, students found problem situations in which case-specific approaches could be generalized and based on this, and they also discovered the effect of multiplication and division operations on both sides. Students applied their solution processes to similar situations in this process and created equation solution processes.

- Self-developed model

Students have enacted the solution processes they have developed. Thus, based on their informal information, students have accessed formal information themselves. The researchers expected the students to create their models and thus complete exploring and interpreting mathematics.

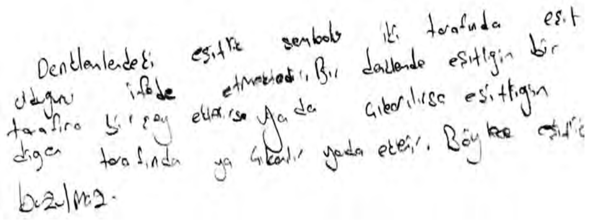
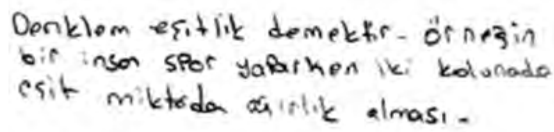
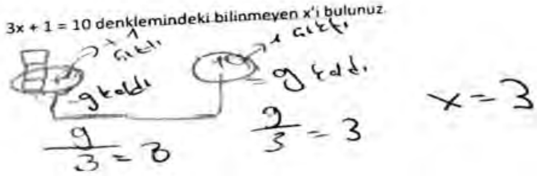
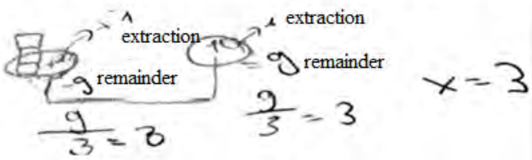
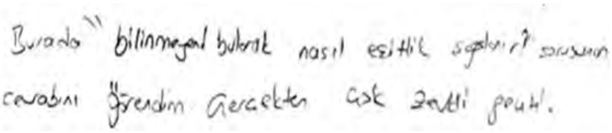
Figure 1. *A section from the short film*

2.8. Analysis of data

Many methods have been used in studies conducted to measure conceptual or procedural knowledge. Rittle-Johnson and Schneider (2014) discussed studies conducted to measure conceptual knowledge in the literature and examined the ways used in these studies. As a result of the examination, they stated that implicit and explicit ways measure conceptual information. For example, conceptual knowledge needs to know which procedural procedure they are doing and why; this is an implicit way to reveal conceptual knowledge (Schneider and Stern 2010). The student's classical definition of the concept is an explicit way to reveal conceptual knowledge. The researchers used both explicit and implicit paths in this study. While analyzing the conceptual and procedural information data, they based on the subject's conceptual and procedural information definitions shown in Table 1 and made content analysis. While analyzing the students' views on the teaching process, they also benefited from content analysis. In this context, they analyzed the interviews and study journals. Two researchers made the analysis process. While analyzing, the researchers repeatedly read the interview texts, evaluated them with line by line reading technique, and created codes. While creating the codes, they considered the data obtained with the relevant literature. They examined the situation that the resulting codes meet the definitions in Table 1. They calculated the analysis's reliability according to the formula developed by Miles and Huberman (1994) and found that it was 88%. Miles and Huberman (1994) emphasized that for excellent qualitative reliability, the reliability should be at the level of at least 80% agreement. Considering this ratio, it can be said that the harmony between the analysts was at a reasonable level in the study. The researchers have identified three concepts related to the subject with the help of the relevant literature. These concepts are equality, unknown, and equation. The researchers realized that three different codes emerged for the concept of equality. These codes are the using of equality symbol correctly, operation, and relation with daily life. Also the concepts of unknown included three codes that are the number representation, representation can vary and emphasize equality. In addition, the concepts of equation involve two codes that are scope and association with daily life. The process to measure procedural information is a little easier than conceptual information. The researchers used the definitions in Table 1 to measure procedural information in the study. Based on these definitions, they looked at the procedural processes (solving styles) of the problems and the accuracy of the students' results. They realized that five codes for question solve styles appeared in the procedural information category. These; solving through the model, solving by making sense, solving the model by thinking, solving in a short way, and classical solution. They evaluated the results of the procedural questions as true and false. The codes formed when they analyze the student views about the process;

Short film effect, a good understanding of the subject, daily life, and entertainment. They gave the analysis framework for the study in Table 6.

Table 6. *Analysis framework for the study*

Category	Description (Table 1)	Code	Sample student response
Conceptual knowledge	Understanding the classical definition and meaning of concepts (Explicit way)	Effect of operations	 The equality symbol in the equations means that both sides are equal. If something is added or subtracted from one side of the equation in an equation, it is also added or subtracted from the other side of the equation. Thus, equality is not broken.
	To justify solving equations using different representations and to relate the concept of equality to equations. (Implicit way)	Associating with daily life	 Equation means equality. For example, when a man is doing sports, he takes an equal amount of weight on both arms.
Procedural knowledge.	Notations, representations, and knowledge of algorithms	Solution over the model	 3x+1= 10 find the unknown x in the equation. 
	Knowledge of formulas and operations to find unknowns in different equations.	The right solution and result	−2a + 3 = 11 − 2 eşitliğinii sağlayan a değerini bulunuz. $-2a+3-3=11-2-3$ $-2a=6$ $a=-3$ -2a + 3 = 11 – 2 find the value of a that satisfies the equation.
Student views on the process		Understanding the topic, enjoy, daily life	 Here, "how to achieve equality by finding the unknown?"

			I learned the answer to the question. It has been delightful.
			bu ders sayesinde denklemlerin günlük hayatta karşımıza çıktığını öğrendim ve ayrıca tüm matematik konuları günlük hayatta karşımıza çıkıp çıkmadığını merak ediyorum. Thanks to this course, I learned that equations appear in our daily life, and I wonder if all math topics come up in our daily life.

* The analysis framework will be better understood in the results section. In the results section, the researchers explained the Turkish answers of the students by translating them into English.

3. Findings

The researchers analyzed the worksheets, interviews, and study journals they used in the study in this section. This section examined conceptual knowledge, procedural knowledge, and student views on the process.

3.1. Conceptual and Procedural Knowledge

In this section, the researchers tried to determine the level of conceptual and procedural knowledge formed in students due to the study. Thus, they sought answers in the research, "What is the effect of realistic mathematics teaching enriched with short films on students' conceptual and procedural knowledge?" They tried to find an answer to the question.

3.1.1. Conceptual knowledge

The researchers extracted the concepts related to "Equality and Equations" and tried to make determinations in this regard. They determined the subject-specific concepts as equality, unknown (variable), equation concepts. They created codes for the concepts and examined the codes they created, meeting the conceptual knowledge definition in Table 1. Conceptual information definition in Table 1; Understanding the concepts and rules of equality and equation; justifying and interpreting equation solving using different representations, associating the concept of equality with equations; understanding the principles of solving equations; Understanding the classical definition and meaning of equality, unknowns, and equations; While solving the equations, it is to distinguish when to add, subtract, multiply, divide both equations in the equation and to know why.

Equality concept

The researchers analyzed the data on the concept of equality and found that three different codes had emerged. These; correct use of the equality symbol, associating with everyday life and effect of transactions.

Table 7. *Codes for the concept of equality and sample student answers*

Concepts	Codes	Student names	Sample student answers
Equality	Correct use of the equality symbol	Dilay	Denklemlerdeki eşitlik sembolü iki tarafında eşit olduğunu ifade etmektedir. The equality symbol in the equation means that both sides are equal.
	Associating with everyday life	Kaan	Denklemdeki eşitlik sembolü sağda neyse solda onun olduğunu belirtir ama ... eklenip çıkarılırsa denge bozulur The equality symbol in the equation indicates that whatever is on the right is on the left. However, the balance is disturbed if only one side

			is added or subtracted.
	Effect of transactions	Batuhan	Denklemlerdeki eşitlik sembolü iki tarafında eşit olduğunu ifade etmektedir. Bu denklemde eşitliğin bir tarafına bir şey eklenirse ya da çıkarılırsa eşitliğin diğer tarafında ya çıkarılır ya da eklenir. Böylece eşitlik bozulmaz. The equality symbol in the equation means that both sides are equal. In this equation, if something is added or subtracted from one side of the equation, it is also added or subtracted from the other side of the equation. Thus, the equality is not broken.

The code for the correct use of the equality symbol seen in Table 7 has emerged in almost all students. The common thing in student responses about the concept of equality is that if there is equality, there are two sides, and these two sides are equal to each other. As seen in Table 7, Dilay is aware that there are two sides in equality and that these two sides should be equal to each other.

In the code of associating with daily life, they realized those four students explained equality with the word "balancing" from daily life. While defining equality, "When there is balance, we can talk about equality, if both sides are equal, it is balanced and equal." A part of Musab's interview is given in Table 8.

Table 8. *Musab's Sample Statement (associating with daily life)*

Student	Statement
Musab	*Researcher:* Can you explain the definition a little more? *Musab:* Considering the scale problems in the short film, we had to maintain the balance and find the correct result to prevent equality from being broken. Then we can say balance instead of the word equality. If the balance is broken, there is no equality.

As seen in the dialogue above, Musab perceives equality as "balancing" and states that he has reached the correct result by doing a procedure that does not disturb the balance while solving the problem. Similarly, they gave Kaan's expression regarding the concept of equality in Table 7. Kaan explains the concept of equality: "The equality symbol in the equation states that whatever is on the right is on the left. If it is added and removed, the balance will be disturbed." Here Kaan has identified equality with the word "balance" like his other three friends. The students' definition of equality based on the word balance can be thought to be the effect of the short film they watched in the first place. The above interview with Musab supports this thought because Musab stated that he made the definition based on the example of scales in the short film.

In the code of the effects of the operations, they realized that the students stated that the operations made to the right or left of the equality would affect the equality. All of the students agree on this issue. The students stated that adding or subtracting unilaterally or not in the same amount would break the equality. Students expressed this situation as "equality is not achieved," "equality breaks down," "balance is disrupted." Seven students stated that the same amount should be added or subtracted to both sides of the equality to ensure equality. The other three students mentioned that only addition and subtraction would break the equality. A part of their meeting with Musab is below.

Table 9. *Musab's Sample Statement (effects of the operations)*

Student	Sample Statement
Musab	*Researcher:* Musab talked about the operations performed in the equations "Whatever is on the right has the same on the left. If something is removed from the right, the balance is disturbed. "You expressed in the form. Can you explain in a little more detail what you mean by this answer?

	Musab: So, if you take something from the right, the balance will be disrupted. Researcher: Why are you trying to keep it in balance? *Musab:* Because there is equality. *Researcher:* So what should we do to restore balance? *Musab:* We have to take the same from the left. *Researcher:* But is the equilibrium broken only when it has gone? *Musab:* When no is added, the balance is disrupted. Even if we divide one side by any number, the balance is broken, and if we multiply, the balance is broken. *Researcher:* So what do we have to do to get the balance again? *Musab:* Whatever we do to one side of equality, the balance will be restored if we do the same thing to the other side.

As seen in the dialogue above, Musab stated how the operations made on the equations would affect the equation. When they examined Musab's statements, they realized that he was aware of what action he did and why, the effect of his actions, and what to do next. Again, they realized that Musab structured his sentences on keeping the balance while expressing the transactions. While expressing this, they thought that he expressed it by being influenced by the scales in the short film. Similarly, they gave Batuhan's views on the operations performed in the equations in Table 7. As seen in Table 7, Batuhan mentioned that both sides of the equality should be equal, and if something is added or removed on one side, it should be added or removed on the other side so that the equality is not broken. Like all students, Batuhan is aware of the impact of the transactions and is aware of what to do to prevent equality in general.

In student responses to the concept of equality, they realized that students made definitions for the concept of equality, that both sides should be in equality in the symbol of equality, how the transactions made affect the equality, associate the concept of equality with equations, and make sense of the concept by associating equality with daily life. They realized that the definitions given by the researchers in Table 1 emerged.

Concept of the Unknown

The researchers established those three codes for the concept of the unknown emerged. These, number representation, the representation may change, are codes of emphasis on equality. They gave the codes for the unknown concept and sample student answers in Table 10.

Table 10. Codes for the concept of unknown and sample student answers

Concepts	Codes	Student names	Sample student answers
Unknown	Number representation	Nida	Harfler Bilinmeyeni göstarir bilinmeyen orda her Hangi Bir sayı Olduğunu göstarir Letters indicate the unknown. Unknown means there is any number there.
	The representation may change	Senem	Denklemde bulunan harfler bilinmeyendir. harflerin farklı olması denklem çözümünü etkilemez hangi harfi yazarsak yazalım sonuç değişmez The letters in the equation are unknown. Different letters do not affect the solution of the equation. No matter what letter we

			write, the result does not change.
	Equality emphasis	Hilal	bilinmeyeni bulursak esitlik saglanır Equality is achieved by finding the unknown.

In the number representation code, while the students talked about the unknown, five students stated that the unknown is the symbol written instead of the number. When they examined the answers of these five students, they found that the students emphasized that the symbols written instead of numbers were letters. When examining other students' responses, students generally "It is the letters in the equation such as x, y, z, ..". or "It is the result we want to find in the equation." They realized that they expressed in the form. Students put ellipsis after these letters because they knew the “unknown” concept was not just about these letters. As a matter of fact, a part of the meeting with Musab is written in Table 11.

Table 11. *Musab's statements about the unknown (number representation)*

Student	Statement
Musab	*Researcher:* The Unknown is "Letters like x, y, z,… in the equation. That is what we want to find. "You expressed in the form. Could you explain this answer a little more? *Musab:* That is how I answered because we always find the result of the letters. Letters such as x, y, z are always used in the equation, so I wrote that. When I think of it, the unknown concept is what we want to find in the equation. More precisely, whatever we want to find is everything written in its place.

As seen in the above dialogue, Musab thinks that the unknown in the equations has a counterpart in numbers. There are four more students who think like Musab. The answer given by Nida, one of these students, is shown in Table 10. Looking at Table 10, Nida defines the concept of the unknown "Letters refer the unknown. The unknown indicates that there is any number there," and, like his other four friends, he thinks that the unknown is the representation of a number.

In the code where the representation may changed, all students stated that different letters would not affect the result. They stated that the letters are only a symbol and that the given symbol does not matter. The continuation of their conversation with Musab on the concept of the unknown is written in Table 12.

Table 12. *Musab's statements about the unknown (representation may changed)*

Student	Statement
Musab	*Researcher:* Is the unknown always expressed with a letter? *Musab:* Actually, I wrote that because they always use letters in the examples. Instead of letters, put a circle instead of a letter or draw a box if you want. The result you find will not change. *Researcher:* Why doesn't the result change? *Musab:* Because if we write it there in a, the result will be the same; if we write it in b, it will be the same. So we can put it in x, we can put it in a, it does not matter. It was already in this video (short film). Although different things such as pasta and rice were put on the scale, the letter we wanted was given. The letters mean unknown. For example, if we do not know the weight of the pasta, it is unknown to us.

In their interview with Musab, the researchers established that he stated that the unknown could be represented by letters and any symbol. They realized that the short film they had watched in the first place affected Musab's thinking like this. They think that this information is essential information for the concept of the unknown. It is an essential finding that all students think like Musab. They gave the statement Senem wrote about the concept of the unknown in table 10. As seen in Table 10, Senem stated that it is not essential that the letters are different in her statement about the unknown concept because it does not affect the solution. When they looked at the statement, they realized that Senem was aware of the reasons for what she was thinking. Because Senem emphasized that the change of the representation is unimportant since the difference of the letters does not affect the solution. This may lead to the conclusion that Senem and her friends who think like Senem make sense of the concept. They found six more students who stated that it was not crucial for the symbols to be different because they did not affect the solution process like Senem. The other three students stated that it was unimportant if the letters or symbols were different without justifying their statements.

In the equality emphasis code, while the students were defining the unknown concept, they realized that two students made the definition based on equality. The statement written by Hilal regarding the concept of the unknown is given in Table 10. As seen in Table 10, while defining the concept of Crescent, he mentioned its place in the equation and said that it is an expression that must be found to provide equality. Like Hilal, Hüsna also emphasized equality while defining the unknown in the answer she gave and defined it as "the value that does not break equality." The researchers found Hilal and Hüsna's awareness of the need to provide equality to find the unknown in the equations, positive for the study, and evaluated it as a separate code.

In the codes created for the concept of the unknown, they realized that the students defined the concept of the unknown, understood that the equation could be solved using different representations, were aware of the place of the unknown in the equation, and gave meaning. This may indicate that it meets the conceptual knowledge expectations in Table 1.

Concept of the Equation

When the researchers analyzed the data for the concept of equations, they found that two codes emerged. These; scope and association with daily life. The codes and sample student answers for the concept of the equation are given in Table 13.

Table 13. *Codes and sample student answers for the concept of equation*

Concepts	Codes	Student names	Sample student answers
Equation	Scope	Furkan	Denklem bilinmeyen rakamların yerin bazı harfler verilir. Denklemli bir işlemde muhakkak eşitlik vardır Some letters are given in place of unknown numbers in the equation. Where there is an equation, there is equality.
	Association with daily life	Batuhan	Denklem eşitlik demektir. örneğin bir insan spor yaparken iki kolunda eşit miktarda ağırlık alması. The equation means equality. For example, a man takes equal weight on both arms while doing sports

In the scope code, while defining the equation, the students defined the concepts that should be in the equation or what they think the equation covers. Some students defined the equation directly through equality, while others defined it through the concept of unknown. The researchers found that there were students who emphasized both the concept of equality and the unknown concept. They realized that five students defined the concept of the equation with equality, three students with unknown, and two students with both equality and unknown concepts. In Table 13, they showed the answer given by Furkan. As it is seen in the answer given by Furkan, "Some letters are given instead of unknown numbers in the equation." In this part, he emphasizes the concept of the unknown, "There is equality in an equational operation." They realized that in his statement, he emphasized the concept of equality. When they looked at this information, they realized that the students had the concepts of equality and unknown as indispensable for the equations.

In the code of associating with daily life, when they examined the students' answers, they ascertained that all students defined the concept of the equation and also associated it with daily life. Students gave examples from daily life such as the see realized, market bags carried in two hands, water carried on two shoulders, weights in both hands of the person doing sports. The researchers put Batuhan's statement on the concept of the equation in Table 13.

Batuhan gave the example that there should be an equal amount of weight on both arms while doing sports. While giving this example, they realized that he made this definition based on the concept of equality. Researchers have given a part of their interview with Musab in Table 14.

Table 14. *Musab's statements about the equation (associating with daily life)*

Student	Statement
Musab	*Researcher:* Musab, what effect did the lesson have? *Musab:* In the past, what we studied in the lesson remained in the lesson. I recently went to the bakery and looked around to see if I could find an example of the equations. After doing this lesson with a short film, I think, even as I walk, what other examples of equations can I find from daily life?

As seen in the interview, Musab does not leave the subject of equations only in class but also looks for equations in life. He attributed the reason to the lesson made with short films. Similar to Musab, researchers' interviews with Dilay are similar. In Table 15 is a part of their conversation with Dilay.

Table 15. *Dilay's statements about the equation (associating with daily life)*

Student	Statement
Dilay	*Researcher:* For associating equations with daily life, "Like when a person goes to the market and wants to provide the same equality in both arms." Could you explain exactly what you mean? *Dilay:* In the video (short film), she related the equation to the scales in the grocery store, and I related it to the market. Because, for example, if the bags on one arm are heavy, your arm will hurt, so I gave an example of doing it evenly. After all, the two sides in the equation have to be equal to each other. For a person in the market to walk upright, the weight of the bags on both arms must be equal. For example, if a person with the same amount of weight in both hands has 5 kg in one arm, 3 kg in the other arm, and another bag, we can find the bag whose weight we do not know from the equation.

As seen in the dialogue above, Dilay gave the example of daily market bags to the subject of equations. He stated that the weight of the bags carried in both hands should be equal, and if not, how many kg should be added to each hand to equalize it. Researchers have seen that Dilay relates equations to daily life, starting from equality and the unknown. They realized that Dilay started from equality while defining the concept of equation but started from both equality and unknown when relating it to daily life. They found that the other student answers were similar as well.

When they examined the codes they created, they realized that they met the definitions in Table 1. The definitions in Table 1 were shortened, and they formed four criteria for conceptual knowledge and gave their connection with the codes in Figure 2.

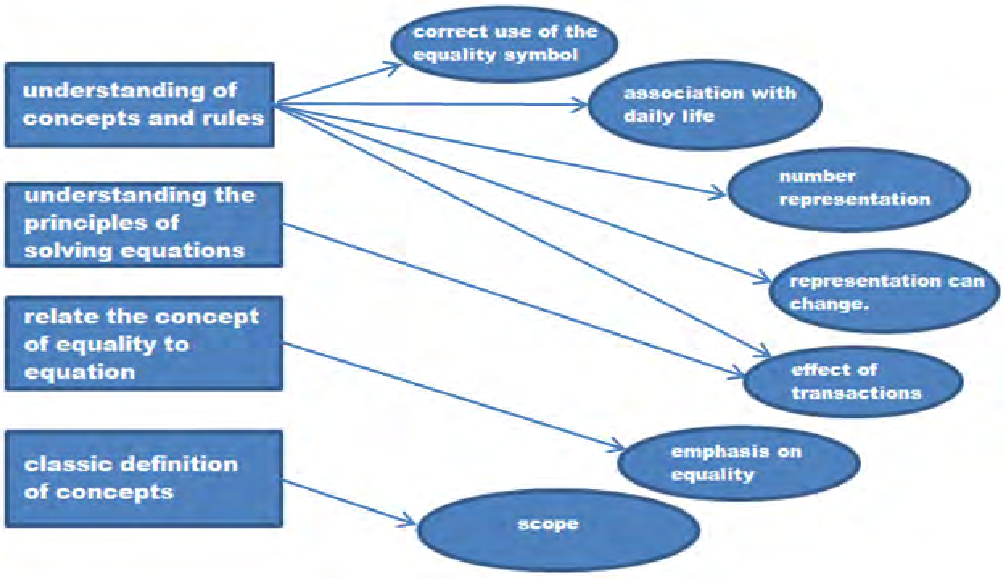


Figure 2. *Relationship of conceptual knowledge definitions with codes*

As seen in Figure 2, the researchers realized that all definitions of conceptual knowledge were met with the study.

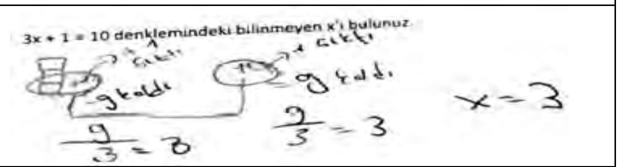
3.1.2. Procedural knowledge

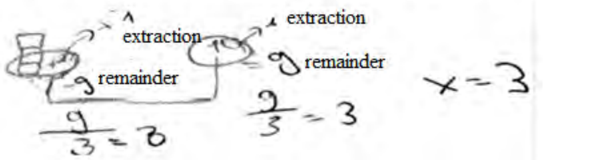
The study analyzed the solutions of the procedural questions given to the students as procedural knowledge. While doing the analysis, they looked at the students' problem-solving styles and the accuracy of the result. In this section, they created the codes for the procedural dimension and examined the levels of the codes they created to meet the procedural knowledge definition in Table 1. As a result of the analyses, they realized that the students' problem-solving styles indicated conceptual knowledge as well as procedural knowledge. However, since procedural questions were examined in this section, they gave this title in the procedural knowledge category. Definition of procedural information in Table 1; Knowledge of definitions of terms, formulas, and operations to calculate the unknown expression. Knowledge of notations, representations, and algorithms. Formula and process knowledge to find unknowns in different equations; knowledge of when and how to use the rules of equations.

Solving styles

When the researchers examined the students' problem-solving styles, they realized that five different codes emerged. These; solution over model, solution by making sense, solution by considering the model, short cut solution, and classical solution. When they looked at the results of the transactions, they observed that there were right and wrong results. The codes of the procedural questions and sample student answers are given in Table 16.

Table 16. *Codes of procedural questions and sample student answers*

Category	Examinatio n method	Composed codes	Student name	Sample student response
Procedural knowledge	Solving styles	solution over the model	Nida	

				3x+1= 10 find the unknown x in the equation. 
		solution by making sense	Ozan	4 = x – 3 denklemini sağlayan x değeri kaçtır? x'ten 3 çıkarıyor ve 4 kalıyor. 3+4=7 4 = x – 3 find the value of x in the equation? Subtract 3 from x and leave 4. 3+4=7
		solution by considering the model	Kaan	6y + 5 = 11 + 6 eşitliğini sağlayan x yerine gelecek sayıyı bulunuz. 6y+5=17-5 6y=12 y=2 Terazi yöntemini aklımda canlandırarak yaptım. 6y+5 =11+6 find the value of y in the equation. 6y+5=17-5 6y=12 y=2 I made the balance method by visualizing it in my mind.
		short cut solution	Musab	–2a + 3 = 11 – 2 eşitliğini sağlayan a değerini bulunuz. a=-3 -2a+3= 11-2 find the value of a that satisfies the equation a=-3
		classical solution	Hüsna	4x -18 = 2x + 14 eşitliğini sağlayan x değerini bulunuz. 4x - 2x = 2x 2x -18 +18 = 14+18 $\frac{2x}{2}=\frac{32}{2}$ = x = 16 18 = 2x + 14 find the value of x that satisfies the equation.
	Results of the transactions	right results	Batuhan	6y + 5 = 11 + 6 eşitliğini sağlayan x yerine gelecek sayıyı bulunuz. 6y + 5 = 17 6y = 12 y = 2 6y+5 =11+6 find the y value in the equation.
		wrong results	Furkan	$-2a+\cancel{3}$ = 11-2=9-3=6 $\frac{-2a}{2}=\frac{6}{2}$ = 3

In the code of solution over the model, they observed that three students solved the questions by reflecting them on the scales. They showed Nida's answer to a question in Table 16. As seen in Table 16, Nida solved the questions by visualizing them on the scales. While making the solution, the transactions made by the equality of both sides; seems to apply to both sides. In the example, he drew three consecutive rectangles representing 3x on the left pan of the scale, added 1 next to it, and put 10 on the right pan. Then he subtracted 1 from both pans of the scale and traded without breaking the equality. There are 3x in the left pan and 9 in the right pan. Then the student divided both sides by 3 and found x to be 3. When they examined the later solutions of Nida, who solved the first two examples on the scales, they realized that she did not draw scales and showed the numbers added or subtracted with arrows. In addition to the solutions, he made in this way, "I solved it with the logic of scales." They realized what you wrote. Their following solutions ascertained that they did not show the added and subtracted ones with arrows but solved them directly by making quick solutions in their minds. They found that the situation was almost the same with other students who solved with scales. They realized students practice their step-by-step solutions. They formed the idea that the students were influenced by the short film when they solved the questions on the scales.

In the code of solution by making sense, it was seen that two students solved the first questions by making sense when they examined the solutions. They observed that the students made the solutions after verbally expressing the mathematical expression given in the question. The researchers gave an example solution of Ozan in Table 16. As seen in the example, Ozan interpreted and made sense of the given equation. When solving the equation 4= x-3, " 3 is subtracted from x and 4 remains." He found x= 7 by adding 3 and 4 after interpreting it as written. They realized that the student who solved the first 3 questions by interpreting them did their solution by applying the rules of solving equations directly without making any sense in the following questions. They ascertained that Furkan, who made similar interpretations in the first questions, made only procedural solutions in the following questions.

In the code of solution by considering the model, they realized that two students showed the additions or subtractions of their solutions with arrows, and next to the solution, they realized sentences expressing that the scale model inspired them. The researchers showed an example solution of Kaan in Table 16. As seen in the solution, Kaan showed with arrows that he subtracted 5 from both sides without drawing scales and found the result correctly. Next to the solution, he wrote sentences expressing that he did it by visualizing the scale method. This showed that the examples inspired the students in the short film. When they examined Nida's solutions, after the first solutions she made by drawing scales, she stated that she solved some questions like Kaan with the help of arrows and solved them with the logic of scales next to her. When both students examined their answers, they realized that they did not show arrows in the following solutions but made classical and fast solutions.

In the code of shortcut solution, they found that three students solved in their minds the last questions. Furthermore, they realized that these students wrote the answer directly next to the question without solving the questions. The researchers showed an example solution made by Musab in Table 16. As seen in Table 16, Musab wrote the answer directly next to the question. Musab attributed his finding the answer without taking any action to his visualization of the scale method in the short film. In Table 17 is a part of the interview with Musab.

Table 17. *Musab's statements about the solving styles (shortcut solution)*

Student	Statement
Musab	*Researcher:* Can you explain why you wrote the answer directly? *Musab:* In the test you gave, the scales came to my mind, and I found the direct answer. *Researcher:* Did you also do the operations from the mind? *Musab:* I did the operations in my mind; when I found the result when I wrote "– 3", the equality was achieved, and when I realized that it was correct, I wrote the answer directly. *Researcher:* Did you do it mentally while testing your accuracy? *Musab:* Yes, I did that in my mind too. Actually, I could do the first questions from my mind, but I solved them at length, and I could do them more straightforward from the mind.

As seen in the dialogue above, the student ascertained that it could be done from the mind and found the result in this way in the last questions. When the researchers examined Musab's previous solutions, they found that he added or subtracted both sides of the equation to leave the unknown alone. They found that Musab solved step-by-step procedural questions faster. When they examined the solutions of Nida and Hilal, who solved the last questions like Musab, they realized that they also accelerated their solutions step by step.

In the code classical solution, they found that all students did some questions with classical solutions. In the study, the classical solution was defined as students adding or subtracting from both sides of the equation to leave the unknown alone and finally finding the unknown by dividing both sides by the coefficient of the unknown. However, they found that the students did not solve all the questions in this way. The researchers showed a part of Hüsna's answer to procedural questions in Table 16. As shown in the solution, Hüsna did the operations of the unknowns among herself while solving and then found 2x. By adding 18 to both sides of the equation, he left the unknown alone without breaking the equation and found 2x = 32. Then he divided both sides by 2 and found x = 16.

When the researchers examined all the solutions, they found that the students did not solve all the questions with a single solution. In general, they realized that the students' first solutions and final solutions were different. They realized that the students took longer to solve the first questions and that they solved the following questions faster by doing some steps in their minds, while some students made solutions from the mind in the last questions. In other words, it can be said that the students' time to solve the questions gradually decreases, and their command of the procedures increases. They ascertained traces of the short film in the solutions made by the students. The fact that the students they interviewed frequently emphasized short films while describing their solutions support this situation. It can be said that short films are influential on students' solution processes. While examining students' solution styles of the problems, they found that four findings obtained: (1) dominate the procedural process while performing the operations; (2) dominate notation and representation information by solving questions in different styles;(3) dominate the formula and process information in the methods used to find the unknowns in different equations and (4) dominate knowledge of when and how to use the rules of equations regardless of solving style. Thus, they found that they met the procedural information definitions in Table 1. In addition, they realized that students' finding shortcuts, making sense of the procedural processes, representing the equation on the scales also pointed to conceptual knowledge. These skills include understanding the concepts and rules given by the researchers in Table 1; understanding the principles of solving equations; showed that the definitions of relating the concept of equality with the equation were met.

Accuracy of answers

The researchers observed that all students tried to solve the questions with correct logic. They realized two students whose way of going was correct but found the result wrong due to carelessness, operation error, or lack of knowledge of the procedure while doing the solution. They found that these students found the wrong answer in only one of the questions. They gave the solution of a question that Furkan answered incorrectly in Table 16. As can be seen, after leaving the unknown alone, Furkan found the wrong answer as a result of dividing the unknown by "2" instead of "-2", which is the coefficient of the unknown. In other words, they realized no mistake in Furkan's equation solution process, and as a result of dividing the unknown into the wrong number, he found the answer wrong. They thought that this mistake of Furkan could be due to carelessness or lack of knowledge. They established that the answers to other questions that Furkan had solved and the solution processes were correct. They showed the operations of a problem that Batuhan solved correctly in Table 16. They realized that Batuhan got the correct result by solving the equation, as many students did.

When they examined the procedural question solutions of all students holistically, they ascertained that the result was wrong in one question of 2 students due to carelessness or lack of knowledge. However, they realized that the solution processes of these students were correct. When they examined the other questions of these two students, they found that the solution processes and results were correct. They realized that the other eight students answered all the questions correctly. They also realized that all students' solution processes were correct. They observed that the students did not solve the questions in a single way while solving. They found these data positive for the study. The fact that students generally solve questions correctly, find correct results in different equations shows that they have a good command of algorithms and formula and operation knowledge. Based on the answers given by the students, the researchers realized that they knew how to apply the rules of equations. Thus, they realized that they met the procedural information definitions in Table 1. Since some of the generated codes are also indications of conceptual knowledge, they showed codes with procedural and conceptual knowledge in Figure 3. They established that the codes created in procedural knowledge also met one of the conceptual knowledge definitions.

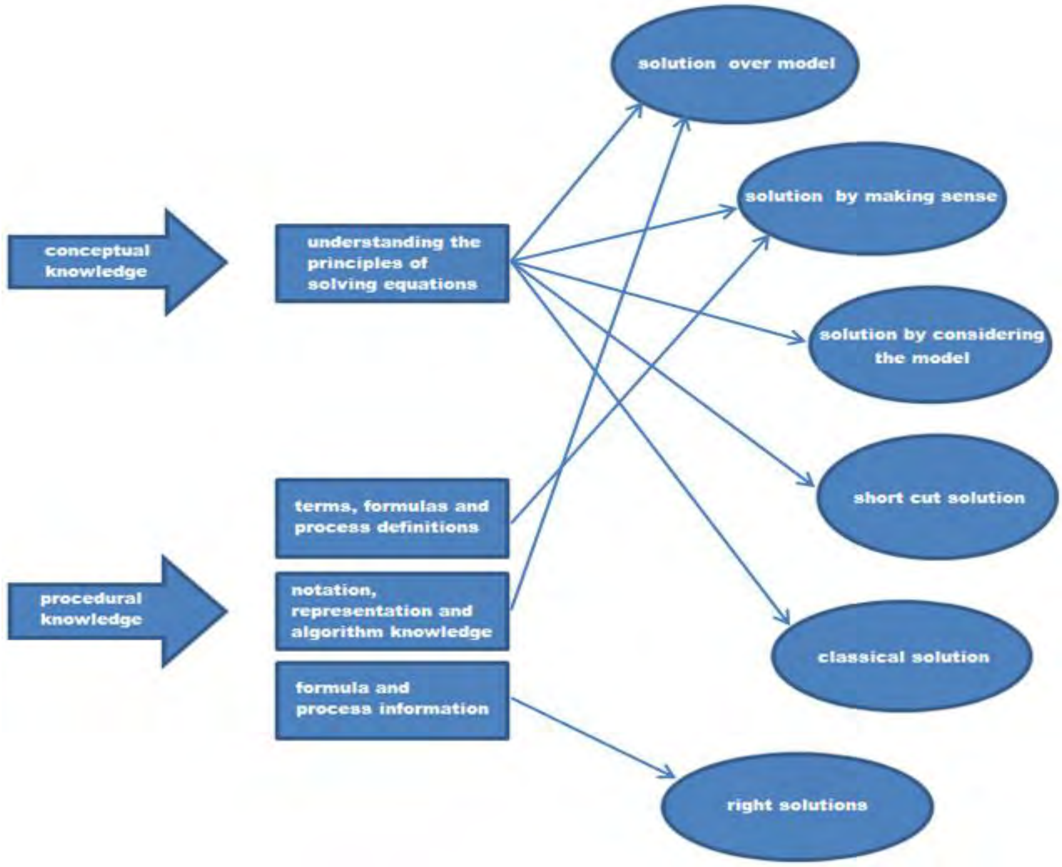


Figure 3. *The relationship between conceptual and procedural knowledge definitions and generated codes*

As shown in Figure 3, all the definitions they created for procedural knowledge were met due to the study. In addition, the solution styles of procedural questions also show the formation of conceptual knowledge in students.

3.2. Student Views on the Teaching Process

The researchers had the students write study journals at the end of the instruction to reveal the students' feelings and thoughts about the teaching process. They also asked Musab and Dilay, whom they interviewed, for their views on the learning process. In this section, they analyzed data collected from study journals, interviews, and worksheets. Thus, the answer sought in the research is "What are the students' views on realistic mathematics education enriched with short films?" they tried to find an answer to the question.

When they analyzed the data, they established that there were four codes for the teaching process. These; Short film effects, a good understanding of the subject, daily life, and enjoy codes. Since it would be more understandable when given without breaking the data, they examined these codes under the same roof.

Short film effect, a good understanding of the subject, daily life, and enjoy

When the researchers analyzed the data, they found that the students liked the short films used at the beginning of the lesson. They realized the effects of the short film both in the answers they gave to the worksheets and in the interviews and study journals. The effect of the short film is that when students examine the worksheets, they try to solve the equations with the scale method, make definitions based on the scales while defining the concepts, and make use of the scales while trying to find out the reason for the operations. In addition to the short film, the students stated in their study journals that the lesson was enjoy, they understood the subject well, and they learned their place in daily life. When they examined the interviews with Musab and Dilay, they realized that four codes appeared in the same way. Thus, students generally think that the lesson, which started with a short film, was enjoy. The codes for the learning process and sample student answers are given in Table 18.

Table 18. *Students' views on the learning process and sample student responses*

Codes	Student Name	Sections from study journals
Short film, enjoy, understanding the subject	Furkan	Bence bütün derslerde kısa filmler kullanılmalı-dır. Çünkü öğrenciler bu sayede dersi iyi anlar ve dersi eğlenceli bulurlar. Short films should be used in all classes. Because in this way, students understand the lesson well and find the lesson enjoyable.
Short film, enjoy	Nida	BU DERS BİZİM İÇİN ÇOK İYİYDİ VE GÖRSEL ANLATIM VARDI DERS ÇOK ZEVKLİ ÇOK EĞLENCELİ GEÇTİ VE ÇOK EĞLENDİK This lesson was perfect lesson for us. There was visual narration, and the lesson was delightful. The lesson was fun; we had much fun in the lesson.
Understanding the subject, enjoy	Dilay	Burada "bilinmeyeni bularak nasıl eşitlik sağlanır?" sorusunun cevabını öğrendim. Gerçekten çok zevkli geçti. Here, "how to achieve equality by finding the unknown?" I learned the answer to the question. It has been delightful.
Daily life	Senem	bu ders sayesinde denklemlerin günlük hayatta karşımıza çıktığını öğrendim ve ayrıca tüm matematik konuları günlük hayatta karşımıza çıkıp çıkmadığını merak ediyorum. Thanks to this course, I learned that equations appear in our daily life, and I wonder if all math topics come up in our daily life.

In the diary section of Furkan above, he wants all lessons to be told with short films, and he attributes the reason to the fact that the short film is both entertaining and helps him understand the lesson better. In this episode written by Furkan, they realized that short films, a good understanding of the subject, and the entertainment dimension emerged. In a part of her diary, Nida mentioned that the lesson went very well, talked about visual narration (short film), and stated that it was enjoy. Senem stated in her diary that she learned the place of equations in daily life thanks to the lesson and wondered whether other subjects were related to daily life. In a section taken from Dilay's diary, they established that she emphasized that she understood the subject well and that the lesson was enjoy. In Table 19 is a part of the interview with Dilay.

Table 19. *Dilay's Statement About the Teaching Process*

Student	Statement
Dilay	*Researcher:* For example, do you think it would be effective if I told you with the scale examples in the book without bringing the scales to you, or if I brought the scales to the classroom and explained with the scales?

	Dilay: No *Researcher:* Why? *Dilay:* Because I felt like I was living the subject in the movie. *Researcher:* What did you mean by "as if alive"? *Dilay:* So it is not compulsory. I learned it by having enjoy. Previously, I felt that mathematics was a compulsory subject, but I realized that mathematics is in our lives in the short film. When I got home, I made scales with pencils and erasers and repeated the equations topic. For example, I am looking for things around me that can be examples of equations. *Researcher:* What did you learn while searching for solutions to the questions in the short film? *Dilay:* It can be said that I learned the subject thoroughly. I think I learned all about the subject we are dealing with, that this subject comes from our lives, and how to solve the questions.

When they looked at the dialogue above, they realized that Dilay was impressed by the short film, understood the lesson well, the lesson was enjoy, and realized the subject's place in daily life. He stated that he was looking for examples on the subject of equations around Dilay. It is an important finding for the study.

Like Dilay, six students stated that they associated the subject with daily life after the teaching process. All students agree that the lesson was enjoy, that they understood the subject well and that the short film was compelling. They observed that the short film stage had a more significant impact on students than other teaching activities in the teaching process prepared for Realistic Mathematics Education. In addition, they realized that it was important data for them to see the place of the subject in daily life like Senem and try to harmonize it with daily life in other mathematics subjects.

4. Discussion

Based on the findings obtained within the scope of the research, it can be said that both the conceptual and procedural knowledge of the students on the subject of "Equality and Equations" is at the desired level after the lesson prepared according to the short film supported RME approach. The study observed that the students formed the conceptual and procedural knowledge definitions given in Table 1. Figure 1 and Figure 2 show the relationship between these definitions and the generated codes. The answers are given by the students to the concepts related to the subject, reflecting these concepts to the solution of equations, expressing equations with different representations from daily life, correct answers by almost all of the students to procedural questions, being aware of which operation and why, and developing different solution styles support this result. According to the RME approach, at the end of the course, the student makes sense of mathematical concepts and reaches formal information based on their informal knowledge (Freudenthal, 1983; Treffers, 1987; Gravemeijer, 1997). As a result of the study, it can be said that the students have conceptual knowledge about the subject and procedural knowledge by developing rules that can solve equation questions correctly; thus, they develop formal knowledge.

The authors established that the students did not stick to a single way of solving procedural questions but solved the questions differently. Regardless of the solution styles, they found that the operations and results were generally correct. It is thought that the short film influences students with high procedural knowledge levels. They realized the effect of the short film in their interviews and solution styles. Because they made sense of adding, subtracting, keeping in balance, leaving the unknown alone on the scales, and realized the place of these situations in solving the equation. Thus, students discovered the rules and steps for solving equations, and it was seen that they always followed the correct processes no matter what style they solved the questions. This indicates the existence of conceptual knowledge as well as procedural knowledge. Looking at Table 1, there is "Understanding the principles of solving equations" in the definition of conceptual knowledge of the subject. Students' solving questions in different styles may indicate that they use the concepts of the subject effectively as well as understanding the principles of solving equations. Because when the solutions of the students who solved the questions on the scales were examined, it was seen that they did the operations that they showed with the boxes in a way that would not disturb the balance (equality). Thus, it can be said that they use the concept of unknown and equality they have learned by visualizing them. This may be due to the integration of procedural and conceptual information with each other. Conceptual and procedural knowledge are two dependent components that complement each other and are very important for success in mathematics (Hiebert & Carpender 1992). In their study, Gün Şahin and Gürbüz observed that with the short film supported RME approach, procedural knowledge as well as conceptual knowledge developed. Thus, it can be said that permanent and functional learning takes place.

Students' understanding of equality was reflected in the equation solutions, and it was seen that they made the solutions based on the concept of equality. According to similar studies in the literature, it has been determined that the most critical factor in understanding the solution of equations in students is the symbol of equality (Theodora & D. Hidayat, 2018; Carpenter et al., 2003). Stephens (2004) draws attention to the fact that one of the main reasons for the difficulties students experience in equations is the meaning that students attribute to the equal sign. For this reason, teachers are expected to teach the lesson by making sense of the symbol of equality while teaching the subject of equations (Castro Gordillo & Godino, 2014; Carpenter et al., 2003). The key to understanding equality is realizing that both sides of the equal sign must be balanced. Any operation performed on one side (addition, subtraction, multiplication, and division) should be performed on the other side (Falkner et al., 1999). For example, Johnson and Alibali (1999) determined three essential criteria in their study to see that equality is formed in the child. These; The definition of the concept, giving real-life examples of the concept of equality, and the transactions made on both sides of the equality effect the equality. In the study, while talking about the definition of equality, the students stated that there are two sides of an equality and that the transaction made to one side should be done to the other side in order not to break the equality. It was seen that they solved the procedural questions based on the concept of equality. It was observed that the students associated the term equality with daily life. By looking at these data, the authors say that they met three criteria determined by Johnson and Alibali to see that the concept of equality was formed in the child. In this case, Gün Şahin and Gürbüz can say that with the study, the students correctly understood the concept of equality.

Concept relations are essential in teaching mathematical concepts (Baki & Kartal, 2004). The authors benefited from the short film they created based on real-life to see these relationships in the study. Van de Walle and Karp Williams (2010) stated that the way to solve an equation is "balancing." Therefore, understanding the concept of balancing becomes essential to understanding the concept of equity. Teachers apply the RME theory in the equation with the concept of "balancing" (Theodora & Hidayat, 2018). In the study, the authors created the short film on balancing and asked questions about it. While the students gave examples of equations from daily life, they realized that they understood the concept of equality as balancing. In the examples they gave from daily life, they gave examples such as keeping the market bags in balance and carrying them balanced while carrying water. Indeed, some students defined equality as balance. This shows that the short film was prepared correctly and effectively according to the RME approach. In the interview with Musab, "Considering the balance problems in the short film, we had to keep the balance and find the right result so that the equality would not be broken. Thus, instead of the concept of equality, we can say balance. If the balance is disturbed, there will be no equality." statement supports this situation. Gün Şahin and Gürbüz realized that while searching for answers to the questions in the short film they watched the students watch at the beginning of the lesson, they found solutions by "keeping it in balance." Thus, it can be said that students learn correctly and effectively with the questions given from the scale example given in the short film. When choosing the scales sample, the researchers expected students to view equality as "balancing". As a result of the study, it can be said that the expectations of the subject of equations were met.

The authors established that the students associated "Equality and Equations" with daily life with the study. Some students wrote in their study journals, "I realized that equations would appear in daily life, I wonder if other mathematical subjects are also used in daily life." they wrote. With this statement, they realized that the students learned the subject of equations in daily life, and it aroused the feeling of wandering about the equivalent of other subjects in daily life. Researchers think that students will be curious about the daily life equivalent of the following mathematics topics, and they will try to find answers to them. This result is compatible with other real-life association studies that show that students not only realize the place and importance of mathematics in daily life but also have an awareness that can guide the discussions on the question of what mathematics does (Özgeldi & Osmanoğlu, 2017; Lee, 2012; Gainsbur, 2008). In addition, students' associating the subject with daily life indicates the formation of conceptual knowledge about the subject. It can be thought that the problems presented with a cross-section (short film) taken from life at the beginning of the teaching process accelerate the process of associating students with daily life by showing the subject in life. Students who associate the subject with daily life do not have difficulty establishing a relationship between formal terms and their previous informal knowledge (Ulfah et al., 2020). At the same time, instead of memorizing the rules and making applications that seem meaningless, they turn to applications that make sense to them.

The authors observed that the students learned the concepts and developed rules for solving equations in the lesson, which started with a short film based on the RME approach. For example, for the short film Dilay, it can be said that "I learned the subject completely. I think I learned all about the subject we are dealing with, that this subject comes from our lives, and how to solve the questions." expressed. At the same time, it is understood that the students solve their solutions based on the scale model and talk about the effect of the short film on understanding the subject in the study journals. It is seen that short films positively affect the students' discovery of mathematics concerning real life, which is the basis of RME. This shows that the short film fulfills the task of presenting the contextual problems, which is the first step in RME and leaves behind the other steps of the RME approach based on the research. This may be because the students first encountered a short film in their mathematics lesson. Alternatively, it can be thought that short films can be an effective teaching material in mathematics teaching. These results are in line with the study of Pellicer et al. (2018). In the study, the subject of equations was handled by using sections from the movies, and some tasks were given to the students after the movie. These tasks are problems that require setting up and solving equations. At the end of the study, it was seen that almost all of the students fulfilled the given tasks. Yıldız and Ürey (2014) mentioned that movies or videos should be used in teaching mathematics. They also stated that mathematics teachers should be aware of the importance of movies in teaching mathematics to get the desired efficiency in activities based on movies.

Some students draw scales while solving the questions, write the equation without drawing scales in the following questions and make signs showing that they have added or subtracted something from both sides with arrows as if there is a scale, finally solving the equation directly without making any scales or markings, Piaget's brings to mind the steps of schema formation, assimilation, adaptation, organization, and reconciliation. They ascertained that the students who solved the questions in this way finally reached a consensus by organizing what they learned.

The authors found that students found the lessons entertaining and instructive. Some students said, “I wish every lesson were like this. The lesson was delightful; we both had enjoy and learned.” Using similar expressions showed that teaching a lesson with a short film makes the lesson enjoy and thus effective. When the studies are examined, many students about mathematics lessons expect mathematics lessons to be more enjoyable (Memnun & Akkaya, 2010; Elçi2006). In order to make the lessons more enjoyable, different teaching methods (such as teaching with the script, teaching with games, creative drama) should be used (Yurtbakan et al., 2016). It can be said that one of the different teaching methods is short film supported RME. In short films, mathematics is not directly explained, but mathematics is given as a cross-section of life, allowing students to watch the short film without getting bored.

5. Conclusion

Considering the study's findings, it was seen that the effect of realistic mathematics teaching enriched with short films on students' conceptual and procedural knowledge was positive. In addition, it was determined that student's views on the teaching process were positive. Gün Şahin and Gürbüz suggest that this method, which is influential in the formation of conceptual and procedural knowledge and makes the lesson enjoy, is applied to other mathematics subjects, and the results are observed. They suggest that short films should be supported not only by the RME approach but also by different teaching methods. Teachers need to be aware of the impact and importance of short films to use them effectively in mathematics teaching. They recommend the implementation of professional development programs in this direction.

Notes

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References

Akkaya, R., & Durmuş, S. (2006). İlköğretim 6-8. sınıf öğrencilerinin cebir öğrenme alanındaki kavram yanılgıları [Misconceptions of Elementary School Students in Grades 6-8 on Learning]. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 31, 1-12

Amaç, R., & Didiş Kabar, M. G. (2019). Matematik öğretmeni adaylarının cebirde harflerin kullanımı ve cebirsel işlemler ile ilgili öğrenci hatalarına yönelik farkındalıkları [Prospective Middle School Mathematics Teachers' Awareness of Students' Errors regarding the Use of Letters in Algebra and Algebraic Operations] . *Egitimde Nitel Araştırmalar Dergisi, 7 (4), 1525*, *1552*.

Altun, M. (2006). The Development in Mathematics Teaching. *Journal of Uludag University Faculty of Education*, *19*(2), 223-238.

Baki, A. & Kartal, T. (2004). Characterızıng Hıgh School Students' Algebra Knowledge In Terms Of Procedural And Conceptual Knowledge, *The Journal of Turkish Educational Sciences*, *2*(1), 27-50.

Baroody, A. J., Feil, Y., & Johnson, A. R. (2007). Research commentary: An alternative reconceptualization of procedural and conceptual knowledge. *Journal for research in mathematics education*, 38(2), 115-131.

Beltrán-Pellicer, P., Medina, A., & Quero, M. (2018). Movies and TV series fragments in mathematics: Epistemic suitability of instructional designs. *International Journal of Innovation in Science and Mathematics Education*, *26*(1).

Blanton, M., & Kaput, J. (2001). Algebrafying the elementary mathematics experience Part II: Transforming practice on a district-wide scale. In *Proceedings of the 12th ICMI Study Conference. The Future of the Teaching and Learning of Algebra* (pp. 87-95).

Booth, L. (1984). Algebra: Children's strategies and errors. Windsor, UK: NFER-Nelson. Booth, L. (1988). Children's difficulties in beginning algebra. In A. F. Coxford (Eds.), The ideas of algebra, K-12 (pp. 20–32). Reston, VA: NCTM.

Bryant, A. L., Schulenberg, J. E., O'Malley, P. M., Bachman, J. G., & Johnston, L. D. (2003). How academic achievement, attitudes, and behaviors relate to the course of substance use during adolescence: A 6-year, multiwave national longitudinal study. *Journal of research on adolescence*, *13*(3), 361-397. 10.1111/1532-7795.1303005

Carpenter, T. P., Franke M. L. & Levi, L. (2003). *Thinking mathematically: Integrating arithmetic and algebra in elementary school*. Heinemann, 361 Hanover Street, Portsmouth, NH 03801-3912 (Paperback: $24.50). Web site: www. heinemann. Com.

Castro Gordillo, W. F., & Godino, J. D. (2014). Preservice elementary teacher´ s thinking about algebraic reasoning.

Çeliköz, N., Duran, B. (2017). Investigating the Effects of Teacher Attitudes on the Mathematics Achievement in the Context of 8th Grade Students' Perspectives. *KEFAD*, 18(3), 564-585.

Dede, Y., & Peker, M. (2007). Students' errors and misunderstanding towards algebra: pre-service mathematics teachers' prediction skills of error and misunderstanding and solution suggestions. *Elementary Education Online*, *6*(1).

Doruk, B., & Umay, A. (2011). The effect of mathematical modeling on transferring mathematics into daily life. Hacettepe Unıversıty Journal Of Educatıon, 41, 124-135.

Elçi, A. N., Bukova-Güzel, E., & Alkan, H. (2006). Ülkemiz matematik öğretmen adaylarının profilinin yapılandırmacı öğrenme yaklaşımına uygunluğu [The suitability of the profile of pre-service mathematics teachers in our country with the constructivist learning approach]. *VII. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi, Gazi Üniversitesi Gazi Eğitim Fakültesi*, 7-9 Eylül 2006, Ankara, 1273-1277.

English, L. D. & Halford, G. S. (1995). Mathematics education: Models and processes. New Jersey: Lawrence Erlbaum Associates.

Ersoy, Y., & Erbaş, A. K. (2005). Kassel projesi cebir testinde bir grup Türk öğrencinin genel başarısı ve öğrenme güçlükleri [General success and learning difficulties of a group of Turkish students in the Kassel project algebra test]. *Elementary Education Online*, *4*(1), 18-39.

Freudenthal, H., (1983). Didactical Phenomenology Of Mathematical Structures. Educational Studies in Mathematics, 24 (2), 139-162.

Gainsburg, J. (2008). Real-world connections in secondary mathematics teaching, *Journal of Mathematics Teacher Education*, *11*(3), 199-219.

Gravemeijer, K. (1997). Solving word problems: A case of modelling? Learning andInstruction, 7(4), 389–397.http://dx.doi.org/10.1016/s0959-4752(97)00011-x

Gümüş, F. Ö., & Umay, A. (2017). Effect of Problem Solving Strategies Instruction on Preservice Elementary Mathematics Teachers' Conceptual /Procedural Solution Preferences and Problem Solving Performance. *Elementary Education Online*, *16*(2), 746 – 763.

Gürbüz, R., & Akkan, Y. (2008). A Comparision of Different Grade Students' Transition Levels froto Algebra: A Case for'Equation'Subjectm Arithmetic. *Egitim ve Bilim*, *33*(148), 64.

Hiebert, J., & Carpenter, T.P. (1992). Learning and teaching with under- standing. In: D. A. Grouns (Ed.), Handbook of research on mathematics teaching and learning (pp. 65-92). New York: Macmillan.

Hiebert, J., & Wearne, D. (1986). Procedures over concepts: The acquisition of decimal number knowledge. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp. 199–223). Lawrence Erlbaum Associates, Inc.

Howson, A. G., & Wilson, B. (1986). School mathematics in the 1990s. Cambridge, UK: Cambridge University Press.

Ishii, D. K. (2003). First-Time teacher-researchers use writing in middle school mathematics instruction, The Mathematics Educator, 13(2), 38-46.

Kadijević, Đ. (2018). Relating procedural and conceptual knowledge. *Teaching of Mathematics*, *21*(1), 15-28.

Kaput, J., & Blanton, M. (2001). Algebrafying the elementary mathematics experience. In *The Future of the Teaching and Learning of Algebra. Proceedings of the 12th ICMI study conference* (Vol. 1, pp. 344-352).

Kar, T., Çiltaş, A., & Işık, A. (2011). Cebirdeki Kavramlara Yönelik Öğrenme Güçlükleri Üzerine Bir Çalışma [A Study on Learning Difficulties for Concepts in Algebra]. *Kastamonu Eğitim Dergisi*, *19*(3), 939-952.

Kaya, D. (2015). Çoklu temsil temelli öğretimin öğrencilerin cebirsel muhakeme becerilerine, cebirsel düşünme düzeylerine ve matematiğe yönelik tutumlarına etkisi üzerine bir inceleme [A Study on the Effects of Multiple Representations-Based Instruction on Students' Algebraic Reasoning Skills, Algebraic Thinking Levels and Attitudes Towards Mathematics].*Dokuz Eylül Üniversitesi, Eğitim Bilimler Enstitüsü, İzmir*.

Kieran, C. (Ed). (1992). The learning and teaching of school algebra. Handbook of research on mathematics teaching and learning. Macmillan Library Reference, New York, 390-419. Grouws, D

Laughbaum, E. (2003). Developmental algebra with function as the underlying theme. *Mathematics and computer education*, *37*(1), 63.

Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2017). How does realistic mathematics education (RME) improve students' mathematics cognitive achievement?. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 569-578.

Lee, J. E. (2012). Prospective Elementary Teachers' Perceptions of Real-Life Connections Reflected in Posing and Evaluating Story Problems, *Journal of Mathematics Teacher Education,* 15(6), 429-452. DOI: 10.1007/s10857-012-9220-5.

Martin, D. B. (2007). Beyond missionaries or cannibals: Who should teach mathematics to African American children?. *The High School Journal*, *91*(1), 6-28.

MacGregor M. & Stacey, K. (1996). Learning to formulate equations for problems, *The Program Commıttee Of The 18th Pme Conference*, 3, 3-289.

Memnun, D. S., & Akkaya, R. (2010). Primary School Seventh Grade Students' Opinions About the Mathematics Course. Journal of Theoretical Educational Science, *3*(2), 100-117.

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

Miller, L. D., & England, D. A. (1989). Writing to learn algebra. *School Science and Mathematics*, *89*(4), 299-312.

Neuman, W. L. (2012). Toplumsal Araştırma Yöntemleri: Nicel ve Nitel Yaklaşımlar III. [Social Research Methods: Quantitative and Qualitative Approaches III]. Cilt (5. Basım). İstanbul: Yayın Odası.

Özgeldi, M., & Osmanoğlu, A. (2017). Connecting Mathematics to Real Life: An Investigation on How Prospective Secondary Mathematics Teachers Build Real Life Connections. *Turkish Journal of Computer and Mathematics Education*, *8*(3), 438-458.

Öztürk, F. Ö. (2017). A Study on Science-Society Based Educational Short Films: Example of Science Education. Mersin University Journal of the Faculty of Education, *13*(2), 633-649.

Pope, L. (1994). Teaching Algebra. Mathematics Education: A Handbook for Teachers. elsington College of Education: New Zealand, 1, 88-99.

Ritchie, S. J., & Bates, T. C. (2013). Enduring links from childhood mathematics and reading achievement to adult socioeconomic status. *Psychological science*, *24*(7), 1301-1308. 10.1177/0956797612466268.

Rittle-Johnson, B., & Alibali, M. W. (1999). Conceptual and procedural knowledge of mathematics: Does one lead to the other? *Journal of Educational Psychology, 91*(1), 175–189.

Rittle-Johnson, B., & Schneider, M. (2014). Developing conceptual and procedural knowledge of mathematics. R. C. Kadosh, & A. Dowker içinde, Oxford handbook of numerical cognition (pp. 1102–1118). Oxford: Oxford University Press.

Rittle-Johnson, B., & Schneider, M. (2015). Developing conceptual and procedural knowledge of mathematics. *Oxford handbook of numerical cognition*, 1118-1134.

Rosnick, P. (1981). Some misconceptions concerning the concept of variable. Mathematics Teacher, 74 (6), 418–420.

Sarama, J., & Clements, D. H. (2004). Building blocks for early childhood mathematics. Early Childhood Research Quarterly, 19(1), 181–189

Sasmaz Oren, F., & Ormanci, U. (2012). An Application about Pre-Service Teachers' Development and Use of Worksheets and an Evaluation of Their Opinions about the Application. *Educational Sciences: Theory and Practice*, *12*(1), 263-270.

Schneider, M., & Stern, E. (2010). The developmental relations between conceptual and procedural knowledge: A multimethod approach. *Developmental psychology*, *46*(1), 178.

Stephens, A. C. (2004). “Equivalence and relational thinking: Preservice elementary teachers’ awareness of opportunities and misconceptions”, *Journal of Mathematics Teacher Education*, 9, 249-278.

Sumirattana, S., Makanong, A., & Thipkong, S. (2017). Using realistic mathematics education and the DAPIC problem-solving process to enhance secondary school students' mathematical literacy. *Kasetsart Journal of Social Sciences*, *38*(3), 307-315.

Theodora, F. R. N., & Hidayat, D. (2018). The use of realistic mathematics education in teaching the concept of equality. *JOHME: Journal of Holistic Mathematics Education*, *1*(2), 104-113.

Treffers, A., (1987). Three Dimensions: A Model Of Goal And Theory And Theory Description in Mathematics Instruction- The Wiskobas Project. Dordrecht: Kluwer.

Ulfah, A. S., Yerizon, Y., & Arnawa, I. M. (2020, May). Preliminary research of mathematics learning device development based on realistic mathematics education (RME). In *Journal of Physics: Conference Series* (Vol. 1554, No. 1, p. 012027). IOP Publishing.

Üzel, D. (2007). Gerçekçi matematik öğretimi (RME) eğitimin ilköğretim 7. sınıf öğretiminde öğrenci kazanımna etkisi. [The effect of realistic mathematics teaching (RME) education on student acquisition in primary school 7th grade teaching]. Yayınlanmamış doktora tezi. Balıkesir Üniversitesi Fen Bilimleri Enstitüsü, 2007.

Van de Walle, J. A., Karp K. S. & Bay-Williams, J. M. (2010). “Developing fraction concepts”, *Elementary and middle school mathematics: Teaching developmentally*, *7*, 286-308.

Vitaro, F., Brendgen, M., Larose, S & Tremblay, R.E. (2005). Kindergarten disruptive behaviors, protective factors, and educational achievement by early adulthood. Journal of Educational Psychology, 97 (4), 617-629, 10.1037/0022-0663.97.4.617

Vlassis, J., & Demonty, I. (2000). La résolution des équations du premier degré à une inconnue. *Cahiers du Service de Pédagogie Expérimentale de Université de Liège*, *3*(4), 35-51.

Weaver, N. (2004) The Kadison-Singer Problem in Discrepancy Theory. Discrete Mathematics, 278, 227-239.
https://doi.org/10.1016/S0012-365X(03)00253-X

Yıldız, C., & Ürey, M. (2014). The Importance Of Fılms and Vıdeos in Mathematıcs Teachıng, Journal of Research in Education and Teaching, 3(1), 429-439.

Yin, R. K. (2009). Case study research: Design and methods (4th Ed.). Thousand Oaks, CA: Sage.

Yurtbakan, E., Aydoğdu İskenderoğlu, T. & Sesli, E. (2016). The Views of the Classroom Teachers On Enhancing The Students’ Success Of Mathematics, Ondokuz Mayis University Journal of Faculty of Education, *35*(2), 101-119.

Authors

Zuhal GUN SAHİN, Kilis 7 Aralik University, Turkey, e-mail: z.gunsahin@kilis.edu.tr

Ramazan GURBUZ, Adiyaman University, Turkey, e-mail: rgurbuz@adiyaman.edu.tr