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Values of Mathematics Education In Turkish High School Mathematics Textbooks

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ABSTRACT

The purpose of this study is to examine how mathematics education values are included in Turkish high school mathematics textbooks. Mathematics education values describe the learning and teaching processes of mathematics. Mathematics education values are considered as five complementary pairs: formalistic view-activist view, operational understanding-relational understanding, relevance-theoretical knowledge, accessibility-special, and evaluating-reasoning. Document analysis method was used in the research. The sample of the study was determined examples in the mathematics textbooks used in high schools in the 2019-2020 academic year. A total of 2175 questions were examined within the scope of the research. Content analysis was used in the analysis of qualitative data, and the obtained data were classified as mathematical value pairs. Accordingly, it was found that values of formalistic view, theoretical knowledge, operational understanding, evaluating, and accessibility were emphasized more than complementary values in the studied books. Accordingly, considering the importance of mathematics education values for mathematics textbooks, it may be advisable to pay attention to the balanced distribution of these complementary value pairs in textbooks.

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1. Introduction

One of the important indicators for mathematical competence as well as cognitive skills such as problem solving and reasoning is affective skills (Uysal and Dede, 2016). Cognitive acquisitions integrated with affective domain skills will enable more qualified and permanent learning in mathematics education (Seah and Bishop, 2000). Values have a very strong influence on increasing quality of mathematics education and on the students' decisions whether to deal with mathematics (Kartasasmita, Bana and Wahyudin, 2014). In mathematics education, students realize that mathematical ideas are open to discussion and proof, and they can understand these values that belong to the nature of mathematics, namely mathematical values (Ernest, 2008). For most students and even teachers, learning mathematics is seen as developing the cognitive field limited by the formulas and concepts in the books. However, mathematics education cannot be carried out without effective learning that includes mathematical values, in addition to teaching cognitive domains (Bilda, 2016). Being clear and consistent of these values emphasized in mathematics learning helps

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individuals to have positive experiences and society to give importance to mathematics by realizing it (FitzSimons et al., 2001). Therefore, mathematics and mathematics education values are important in terms of what and how much are valued in the learning process (Kirez, 2018). Mathematics education values are the values that emerge as a result of the interaction of general educational values and mathematical values (Seah et al., 2016). Mathematics education values describe the learning and teaching processes of mathematics (Seah and Bishop, 2002). These values are reflected in the curriculum, teachers' lessons, and activities. (Kirez, 2018). Also, students develop learning paths and strategies thanks to these values they have (Cao, Seah and Bishop, 2006). In this context, when the mathematics education values of students are combined with the values that teachers have, a situation occurs that positively affects the quality of education and training (Panal, 2012). Bishop (1996) classified the values of mathematics education as five complementary pairs of values. Seah (1999) stated that the conceptual structure of these value pairs can differ according to cultures and stated that many mathematical education values can exist in the mathematics learning-teaching process. With this idea, it has been classified as the most used and adopted values among the values of mathematics education. The five-value pairs that makeup Seah's (1999) mathematical education classification of values: formalistic view-activist view, operational understanding-relational understanding, relevance-theoretical knowledge, accessibility-special, and evaluating-reasoning.

The formalistic value is the learning value that aims to teach mathematical knowledge consisting of concepts, formulas, theorems, and symbols through presentation (Kirez, 2018). At this value, mathematical definitions and skills are transferred with teacher-centered learning where the student is more listener. Contrary to its formalistic value, the activist view value advocates the learning of mathematics through discovery (Seah, 1999). The activist view value describes the process of exploring patterns with generalization and abstraction, attaches importance to students' being active and making their discoveries (Umay, 2003). Operational understanding value is based on Skemp's (1978) definition of operational understanding in mathematics education. In operational knowledge, there is a situation of knowing how to use it without seeing the need to know the reason for a concept or an operation (Baki, 2014). Relational understanding value is a process that enables understanding the ideas behind mathematical formulas and concepts, in contrast to the operational comprehension value (Kirez, 2018). When these two values are given in a balanced way in the learning process, the subjects are learned at the level of comprehension (İşleyen and Işık, 2003). Relevance value describes the relationship of mathematics to daily life and other lessons (Seah and Bishop, 2000). On the other hand, the value of theoretical knowledge refers to the abstract giving of mathematical knowledge detached from daily life. Accessibility value indicates that mathematical knowledge can be learned by everyone (Gunstone et al., 2007). As an example of this value, asking a question that all students can comment on in the classroom can be given. On the contrary, the idea that mathematical knowledge is only for people with interest and ability in mathematics is emphasized in special value (Seah and Bishop, 2000). Evaluation value emphasizes the ability to apply mathematical knowledge in research and problem solving (Seah, 2000). Reasoning value is the process of reaching a decision or a result using mathematical knowledge (Umay, 2003). Reasoning value emphasizes the ability to synthesize and analyze using mathematical thinking (National Research Council, 2009). This provides a higher level of cognitive domain learning than assessment value.

Mathematics education values can differ in each country as a result of education and training approaches. This change takes place with the teacher's different teaching practices, content, and activities in the textbooks (Seah et al., 2016). In this respect, the teacher and the textbook are the two most effective factors in the formation and transmission of values in students (Seah, 2007). The mathematics teacher performs the transfer of knowledge by using different mathematics education values in mathematics lessons (Bishop, 1996). Also, textbooks are as important as teachers and are directly related to mathematics education values (Seah, 2000; Pepin and Haggarty, 2001). Mathematics textbooks have great importance in mathematics education as they make the knowledge concrete for the student (Altun, 2008). The books, which are prepared by experts in education and enable them to reach the desired goals as soon as possible, are the most preferred educational materials by teachers

(Haggarty and Pepin, 2002; Johansson, 2003). Textbooks are an important opportunity for students' self-development. Textbooks have a different place among other teaching tools in terms of allowing students to repeat, reinforce and organize their knowledge (Hare, 1999; Issitt, 2004). For this reason, the textbook should attract the attention of the student and arouse interest in the course. Textbooks should contain pictures, graphics, stories, etc. related to the subject. Textbooks should contribute to the student's learning by living by providing opportunities for student self-learning (Singh, Yusoff and Hoon, 2020). All these explanations about textbooks are related to the mathematical values and mathematical education values contained in these books (Seah and Bishop, 2000). Textbooks, which have a very important place in education, are the most valuable tools for shaping, transferring, and developing mathematics and mathematics educational values (Amit and Fried, 2002).

In the mathematics education literature, it is known that studies are investigating mathematics education values. Some of these include teachers', prospective teachers' and students' approaches to mathematics education values (Sam and Ernest, 1997; Seah, 2004; Durmuş, Bıçak and Çakır, 2008; Dede, 2009; Doruk, 2012; Peng and Nyroos, 2012; Zhang et al. , 2015; Kirez, 2018) have researched, very few studies are about the reflections of mathematics education values in textbooks (Seah, 1999; Seah and Bishop, 2000; Dede, 2006; Özenç, 2019; Yaprakgül, 2019). In his study, Dede (2006) concluded that in the 9th, 10th, and 11th-grade secondary school mathematics textbooks, formalist perspective, theoretical knowledge, operational knowledge, evaluation, and accessibility values are given more space than complementary mathematics education value pairs. In Özenç's (2019) study, it was stated that in 5th, 6th, 7th and 8th-grade middle school mathematics textbooks, formalistic view, operational understanding, theoretical knowledge, accessibility, and evaluation values were emphasized more than complementary mathematics education value pairs. Seah (1999) examined the relationship between mathematics and mathematics education values found in secondary school mathematics textbooks in Victoria and Singapore. While there is a balanced distribution for relevance and theoreticism values in both mathematics textbooks, it has been observed that other values such as formalist perspective, operational understanding, customization and evaluation are emphasized according to their complements. Seah and Bishop (2000) drew attention to the differences in the transfer of mathematics education values in mathematics textbooks belonging to the 7th and 8th grades of secondary schools used in Victoria and Singapore. In his study, Yaprakgül (2019) examined the mathematics education values of a total of 583 mathematics questions in the secondary education entrance exams in Turkey, TEOG, LGS, and international PISA and TIMSS exams. It is stated that in TEOG and LGS exams, formal perspective, operational understanding, theoretical knowledge, accessibility and evaluation values are emphasized more than their complementary pairs. In PISA and TIMSS, on the other hand, it was stated that active perspective, operational understanding, relevance, accessibility, and evaluation values were emphasized more than the complementary pairs.

There is no study investigating how high school mathematics textbooks in Turkey reflect the values of mathematics education in the literature. For this reason, the purpose of this study is to examine how mathematics education values are included in the high school mathematics textbooks used in Turkey and the problem sentence of the study is as follows: "How and to what extent are mathematics education values included in high school mathematics textbooks used in Turkey in the 2019-2020 academic year?".

2. Methodology

In this study, in which the values of mathematics education in high school mathematics textbooks were analyzed, document analysis method, one of the qualitative research methods, was used. The document analysis method is a data collection technique that includes the analysis of written materials containing information about the phenomenon or facts aimed to be investigated (O'leary, 2004; Yıldırım and Şimşek, 2016). Within the scope of the purpose of the research, document analysis is made by examining the textbooks (Çepni, 2014). The document analysis method, which is a very useful but less used approach for studies in educational sciences, is a scientific method that requires attention in the research stages (O'leary, 2004). Cardno, Rosales-Anderson and McDonald (2017)

define document analysis as an individual and passive method and in this respect, they state it as a method that researchers in educational sciences are interested in. In this study, the analysis of the documents was carried out by paying attention to the stages of reaching the documents, checking the authenticity, understanding the documents, analyzing the data, and using the data (Yıldırım and Şimşek, 2016).

2.1. Data Collection

In the research, 9th, 10th, 11th, and 12th-grade mathematics textbooks used in Turkey in the 2019-2020 academic year, were examined. Convenience sampling, one of the purposeful sampling methods, was preferred in the study (Özmen and Karamustafaoğlu, 2019). In this context, mathematics textbooks used by the first author, who is a teacher, were selected for the research. In the research, lectures, examples with solutions, and unresolved questions in the textbooks were discussed. A total of 2175 samples were examined within the scope of the research. These textbooks were given codes as M9, M10, M11, M12, respectively. Detailed information about the analyzed textbooks is given in Table 1.

Table 1. Information on textbooks

Grade Level	Publisher	Publication Year	Code	Number of Pages	Number of Samples
9	MEB	2017	M9	376	569
10	Aydın	2019	M10	308	780
11	Top	2018	M11	352	524
12	Tutku	2019	M12	305	302

2.2. Data Analysis

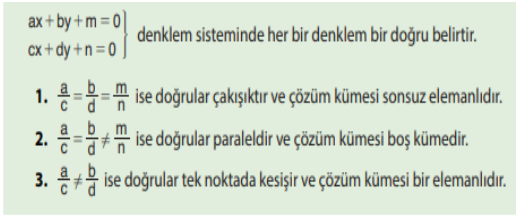
The data obtained as a result of examining the textbooks were transferred to the computer environment completely. In this study, semantic content analysis was used to examine the textbooks. While the content analysis method was used in the analysis of qualitative data, the data were classified as math education value pairs as described in the literature (Yıldırım and Şimşek, 2016). The frequency and percentages of the obtained data were calculated and shown in the study. While determining the mathematics education values examined within the scope of the problem of the research, attention was paid to the relevant literature. According to this, the formalistic view value is a value that emphasizes the learning of rules and formulas in mathematics learning and attaches importance to step-by-step processing. Activists view value as a value that supports the intuitive aspect of the learner. This value includes the activities, lectures, and questions that the students reach a result by guessing with their predictions. In the operational understanding value, attention has been paid to the examples in which only formulas are used and that require operations. In relational understanding, lectures showing the relationships between concepts and examples focusing on the fundamentals of formulas, rules, and operations were examined. In the convenience value, examples and lectures that provide a relationship between mathematical knowledge and real-life were examined. For the value of theoretical knowledge, examples and lectures that are disconnected from real life and that contain only the abstract form of mathematical knowledge have been examined. For the value of accessibility, simple exercises that support the idea that mathematics can be learned for everyone, easy math activities that the whole class can participate in were examined. In the special value, difficult and complex questions that can only be done by students who are interested in mathematics and are talented were taken into consideration. In the evaluation value, the questions that can be solved with basic information and procedures, using familiar ways found at the end of the subject and unit, were examined. For the value of reasoning, examples from the questions at the end of the topic and unit that require students to set up their problems and find different solutions were analyzed. Mathematics education values are summarized in Table 2 below.

Tablo 2. Mathematics Education Values

Mathematics Education Values	**Indicators of Values**
formalistic view	Teacher-centered teaching through presentation, student passive, only rule and formula.
activists view	Teaching by invention, supporting the intuitive side, active participation.
operational understanding	Memorizing only the operational process of rules, formulas and operations, giving shortcuts, direct problem solving.
relational understanding	Focused on conceptual understanding and association, where the foundations of rules, formulas and operations are at the forefront.
convenience	Real-life outcomes of mathematical knowledge.
theoretical knowledge	Teaching mathematics abstractly and detached from real life, focused on formulas.
accessibility	Doing mathematical activities as a whole class with the idea that everyone can learn mathematics.
special	Dealing with the student group who are successful in mathematics and preparing special studies and questions for them.
evaluation	Using questions that use familiar ways and contain basic information and operations.
reasoning	Gaining mathematical knowledge and skills at the level of synthesis and evaluation steps; questions with unorthodox solutions in which he is asked to pose his own problem.

(Özenç, 2019).

Below are examples of how coding is done while analyzing the data.



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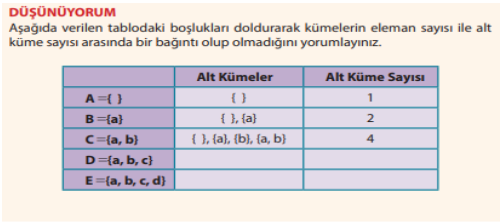
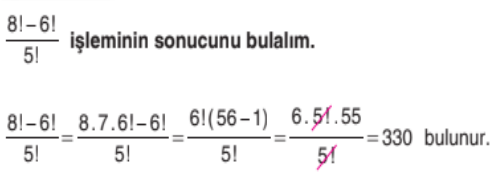


b)

Figure 1. Examples of Formalistic View-Activist View Values from the M9 Textbook

In the example in Figure 1.a, some rules and formulas are given about equations. For this reason, the example is included in the formalistic view value. The activity in Figure 1.b is included in the activist view value because it aims to teach about clusters through discovery.



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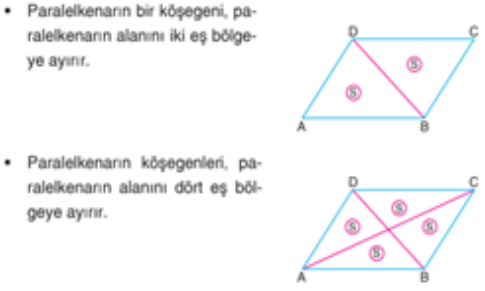
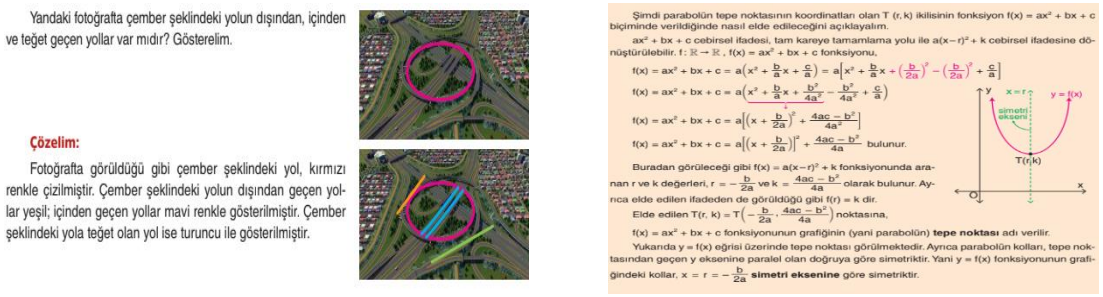


b)

Figure 2. Examples of Operational Understanding-Relational Understanding Values from the M10 Textbook

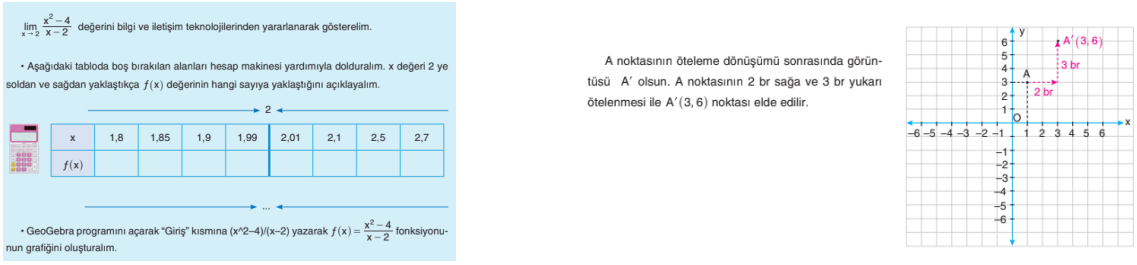
The example given in Figure 2.a is included in the operational understanding value because it contains only mathematical operations. In the example in Figure 2.b, the relationship between the diagonals of the parallelogram and the areas of the newly formed triangular regions is emphasized. For this reason, the sample was included in the relational understanding value.



a) b)

Figure 3. Examples of Relevance-Theoretical Knowledge Values from the M11 Textbook

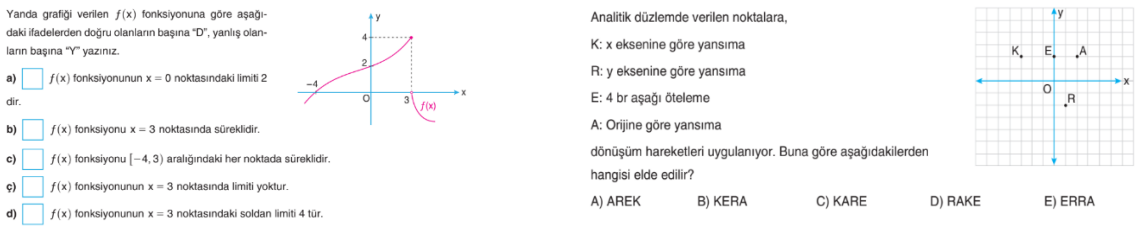
Figure 3.a shows an example about the circle that aims to establish a link between mathematics and daily life. Therefore, the question was included in the relevance value. In the example given in Figure 3.b, mathematical definitions containing abstract information, far from daily life, are given. Therefore, the example is included in the theoretical knowledge value.



a) b)

Figure 4. Examples of Accessibility-Special Values from the M12 Textbook

In the example given in Figure 4.a, students are asked to create graphics using computer software such as a calculator and GeoGebra. This activity is expected to be held by students who are interested in mathematics, so the example is included in the special value. In the example given in Figure 4.b, the subject is explained with a simple example that every student can do. Therefore, this example is included in the accessibility value.



a) b)

Figure 5. Examples of Evaluating-Reasoning Values from the M12 Textbook

In the example in Figure 5.a, some questions are asked to evaluate the basic information about limit and continuity, so the example is included in the evaluation value. In the example given in Figure 5.b, students are asked to produce their solutions regarding transformations. So the example is included in the reasoning value.

2.3. Validity and Reliability

The validity of the research is directly proportional to the validity of the analyzed textbooks. Since the textbooks are approved by the Ministry of National Education (MEB) and used in Turkish high schools, there is no doubt about the validity of the study. To ensure the reliability of the study, the analysis of the collected data was made by the researcher and three observers with similar educational backgrounds. Two of them are high school mathematics teachers who have a master's degree in mathematics education, and the other researcher is an academician who does research in the field of mathematics education. For this study, randomly selected 300 questions were sent to each of the observers from the collected data. Three observer views were taken to group the mathematics education values of these questions. The analysis process started after the observers learned about values and read the necessary information. If the opinions of the researcher and the observers about the questions are the same, it is evaluated with "1", and if they are different, it is evaluated with "0". The data obtained were analyzed with an online program that calculates encoder reliability. Fleiss's Kappa coefficient was used in evaluating the items that were categorized because the number of observers was more than two (Fleiss, 1971; Gordis, 2014). The obtained value of κ (0.849) shows that there is a very good level of agreement between observers (Landis and Koch, 1977). Therefore, it can be said that the reliability of the study is high.

3. Results

Within the scope of the study, it was investigated how much the 9th, 10th, 11th, and 12th-grade mathematics textbooks reflect the values of mathematics education. The findings obtained in the research were expressed in percentages for each textbook.

The graphic showing the proportion of formal look-active gaze value pair in the examples in the textbooks is given in Figure 6.

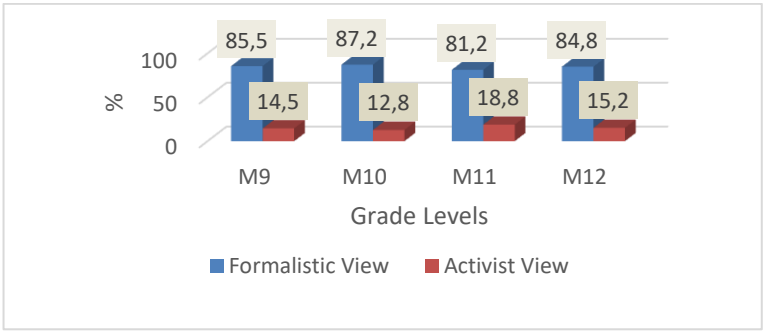


Figure 6. Formalistic View-Activist View Values in Textbooks

According to Figure 6, it is seen that the formalistic view value is dominant in all textbooks (85.5% in M9, 87.2% in M10, 81.2% in M11, and 84.8% in M12). The graph showing the proportion of the operational understanding-relational understanding value pair in the examples in the textbooks is given in Figure 7.

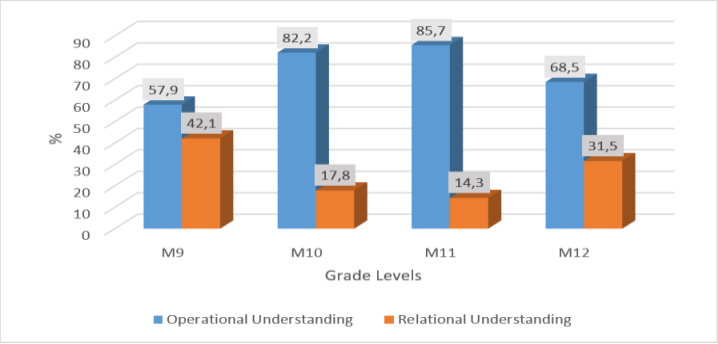


Figure 7. Operational Understanding-Relational Understanding Values in Textbooks

According to Figure 7, it is seen that operational understanding value is dominant in all textbooks (Grade 9; 57.9%, Grade 10; 82.2%, Grade 11; 85.7% and Grade 12; 68.5%). However, the relational understanding value has a more prominent weight in the 9th grade (42%) and 12th grade (31.5) mathematics textbooks compared to the other grades. The graph showing the proportion of the relevance-theoretical knowledge value pair in the examples in the textbooks is given in Figure 8.

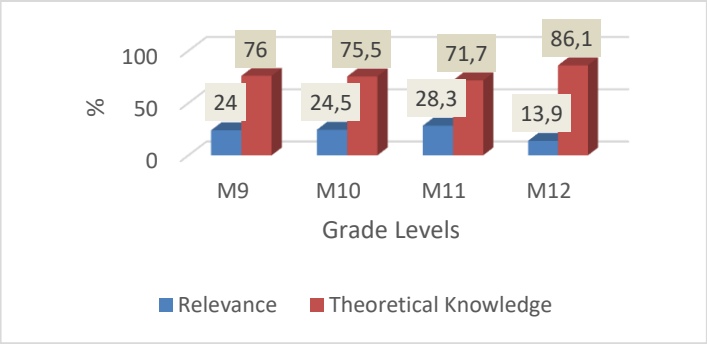


Figure 8. Relevance-Theoretical Knowledge Values in Textbooks

According to Figure 8, the theoretical knowledge value is dominant in the 9th grade (76%), 10th grade (75.5%), 11th grade (71.7%), and 12th grade (86.1%) mathematics textbooks. However, the value of theoretical knowledge appears to be more dominant in the 12th-grade textbook compared to other books. The graph showing the proportion of the accessibility-special value pair in the examples in the textbooks is given in Figure 9.

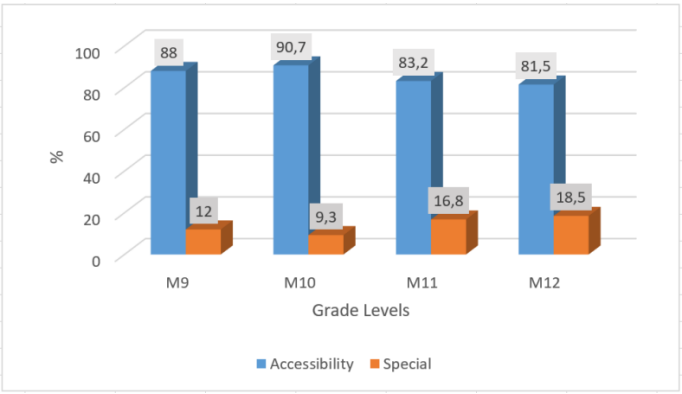


Figure 9. Accessibility-Special Values in Textbooks

According to Figure 9, it is seen that accessibility value is dominant in all textbooks (88% in M9, 90.7% in M10, 83.2% in M11, and 81.5% in M12). The graph showing the proportion of the evaluating-reasoning value pair in the examples in the textbooks is given in Figure 10.

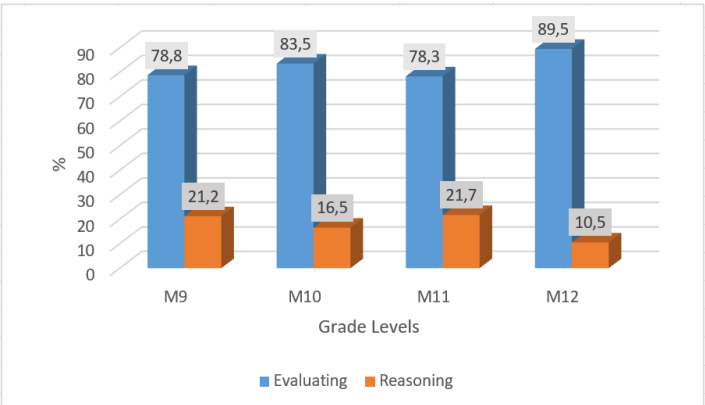


Figure 10. Evaluating-Reasoning Values in Textbooks

According to Figure 10, it is seen that the evaluation value is dominant in all textbooks (78.8% in M9, 83.5% in M10, 78.3% in M11, and 89.5% in M12).

4.Discussion

In this study, which aims to investigate how mathematics education values are included in Turkish high school mathematics textbooks, it was seen that formalistic view value is emphasized more than activist view value in all books. In the formalistic view value, rules, theorems, formulas, and step-by-step operations are valuable. Teacher-centered education is carried out within the scope of this value. In the active gaze value, which forms the basis of constructivist education, mathematical inquiry, guessing the solutions of problems, and learning by discovering are valued. The more emphasis on the formalistic view value in the textbooks can be considered as a natural result for our country, which is an exam country. The preparation process for exams pushes education to the value of the formalist view. Also, it can be said that test technique-oriented training and trying to solve with shortcuts without understanding contributes to the increase in the weight given to this value during the preparation process for exams. It would be more appropriate for constructivist education to reflect both values in the textbooks in a more balanced way.

Considering the values of operational understanding-relational understanding, it was concluded that the distribution in the 9th and 12th-grade textbooks was partially balanced, but especially in the 10th and 11th-grade textbooks, the value of operational understanding was dominant. Operational understanding is the memorization of the operational process step by step without explaining the mathematical rules and formulas (Skemp, 1978; Seah and Bishop, 2000). It is thought that the application of the test technique for university entrance exams in our country causes more emphasis on this value. Also, the relational understanding value is the realization of learning by knowing where the rules and formulas come from and establishing relationships between concepts. It is thought that this type of teaching can increase the student's interest in mathematics. For these reasons, it can be said that the relational understanding value should be emphasized more at the 10th, 11th, and 12th grades level and that both values should be distributed in a balanced way.

In the relevance-theoretical knowledge value pair, it was seen that there is much more emphasis on the value of theoretical knowledge in the textbooks. Theoretical knowledge value is based on the approach that mathematics teaching is possible with abstract theoretical knowledge. In the relevance value, the emphasis is placed on the relationship of mathematical concepts and formulas with daily life. Associating the theoretical knowledge with daily life can increase the motivation of the student in the lesson. The unbalanced distribution between these two values causes most students not to see the equivalent of mathematical knowledge in daily life. However, mathematical knowledge and skills help to solve problems in daily life and provide creative solutions that enable the development of society (Seah, 2007). Also, with the relevance value, the information becomes more interesting and permanent (Gunstone et al., 2007). Therefore, it can be said that these two values should be distributed in a balanced way by placing more emphasis on the relevance value.

Looking at the accessibility-special values, it is seen that the value of accessibility is emphasized too much, and special value is not included in some subjects. The idea that everyone can learn mathematics is included in the accessibility value (Seah, 1999). Thus, an environment suitable for each student to share his / her opinion is created. On the other hand, there is a prevalent belief that mathematics can only be understood by special people with talent (Seah, 1999). High school textbooks in our country are published separately for Science High Schools and separately for Anatolian High Schools. In this study, the books distributed at the Anatolian and Vocational High School level were examined. It is thought that more emphasis is placed on the special value in the textbooks prepared for Science High Schools. This can be shown as one of the reasons why the value of special is underestimated in the textbooks. It is thought that the balance of these two values will contribute to the awareness of students' abilities. Because any student can achieve much more than expected by

offering solutions for an example of elite value. There are examples of this in education. Therefore, it can be said that special value should be emphasized more at all grade levels.

In the evaluation-reasoning value pair, it is seen that the distribution of these two values is unbalanced. The evaluation value is emphasized more than the reasoning value at each grade level. Evaluation value has a very important place in the steps of knowing, applying routine steps, researching, and problem-solving in mathematics education (Gunstone et al., 2007). These steps are the first stages of learning. In reasoning value, importance is given to education at the level of synthesis and evaluation steps. As a result of the balanced distribution of these two values, students combine their mathematical knowledge and understanding with their ideas to enrich their learning.

5.Conclusion

In this study, it was determined that formalistic view, theoretical knowledge, operational understanding, evaluation, and accessibility values are given more place in mathematics textbooks than complementary value pairs. The results of this research show similarities with the study results of Seah and Bishop (2000). However, the result that accessibility value was emphasized more in the textbooks of our country stands out as the biggest difference between these two studies. And in Yaprakgül's (2019) study it is stated that in TEOG and LGS exams, formal perspective, operational understanding, theoretical knowledge, accessibility and evaluation values are emphasized more than their complementary pairs. In PISA and TIMSS, on the other hand, it was stated that active perspective, operational understanding, relevance, accessibility, and evaluation values were emphasized more than the complementary pairs. Also, the results of this study and Dede's (2006) study results overlap with each other. Dede (2006) examined the 9th, 10th, and 11th-grade secondary school mathematics textbooks and concluded that formalistic view, theoretical knowledge, operational understanding, evaluation, and accessibility values were included more than complementary value pairs in textbooks. Also, Özenç's (2019) study and the results of this study largely overlap. Özenç (2019) examined 5th, 6th, 7th, and 8th-grade middle school mathematics textbooks and concluded that formal perspective, operational understanding, theoretical knowledge, accessibility, and evaluation values were more emphasized in textbooks.

6.Recommendations

In line with the results obtained in this study, it was seen that mathematics textbooks should be prepared by going through a more conscious preparation period. The values should be included in the books in a more balanced way. In this sense, in line with a scientific framework, programs should be developed by taking the opinions of researchers working on these issues academically. Seminars should be organized to inform mathematics teachers, book authors, program development experts on the values of mathematics education.

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