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Analysis of Secondary School Mathematics Curriculum Learning Outcomes by TIMSS-2019 Cognitive Domain Skills

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Abstract

This study aimed to analyze the learning outcomes in the 2018 secondary school mathematics curriculum according to TIMSS-2019 cognitive domain skills by using qualitative research method and document analysis. The study evaluated a total of 215 learning outcome statements in the Secondary School (5th, 6th, 7th, 8th Grades) Mathematics Curriculum published by the Board of Education and Discipline according to learning domains and grade level, taking into account TIMSS cognitive domain skills. Since some of the learning outcome statements in the curriculum contain more than one level, 268 outcome statements were categorized. According to the findings obtained from the research, approximately 28% of all learning outcome are in knowing, 48% in applying, and 24% in reasoning cognitive domains. The cognitive domain of knowing is mostly observed in the 5th grade learning outcomes. The applying domain is mostly observed in the 7th grade. The reasoning domain is observed at the highest rate in the 8th grade while it is observed with the lowest rate in the 5th grade. Remarkably, the applying cognitive domain is included the most in all learning domains in the distribution of the cognitive characteristics of the learning outcomes based on the learning domains. While the cognitive domain of reasoning takes place in the data processing learning domain at the highest rate; the cognitive domain of knowing is mostly located in the learning domain of numbers and operations.

Keywords: Secondary school curriculum, secondary school mathematics course, cognitive domain skills, TIMSS.

Introduction

The education program is the totality of all planned educational activities that are implemented to ensure that students can reach pre-identified educational goals (Başaran & Çınkır, 2013). The implemented education programs significantly affect the quality of education (Erden, 1998), therefore, it is crucial to ensure their efficiency and functionality. The curriculum, described as the most important sub-program of the education program, is a mechanism of experiences including all intra and extracurricular activities planned to bring the objectives determined at the grade level related to a lesson in line with the aims of the education program (Kartal & Yazgan, 2016). The information in the curriculum about which content to teach and how to evaluate according to the teaching objectives and grade levels makes the curriculum a roadmap for teachers (Büyükkaragöz, 1997; Bobbitt, 2017; Ersoy, 2006; Goodlad, 1979).

Today, the rapid advances in information has pointed to the need to train qualified individuals who can keep up with this transformation, which in turn has signalled the significance of updating the education and training field to meet this change. Countries constantly update their curricula and adapt their teaching objectives to internationally accepted criteria to train qualified individuals in a rapidly changing world (Özkaya, 2021). International examinations are used as criteria for determining the quality of curricula (Hook, Bishop & Hook, 2007). Trends in International Mathematics and Science Study (TIMSS), which evaluates the curriculum in the field of science and mathematics, is one of the exams with a wide application area that allows international comparisons. While TIMSS measures the performance of 4th-8th grade students in mathematics and science, it also provides information on how student achievement has changed over this period. Thus, the countries participating in the exam can follow their own developments on the one hand, they have the opportunity to compare their results with other countries on the other (MoNE, 2016). Countries also have the opportunity to review their curricula and shape education reforms accordingly (Hiebert et al., 2003; Johansson & Hansen, 2019; MoNE, 2016). As a matter of fact, it can be claimed that the content of international exams is taken as

criteria in the structuring of learning domains and learning outcomes while adapting the curricula by the Ministry of National Education [MoNE] in Türkiye (MoNE, 2018).

Unlike the previous programs, a student-centered education approach was adopted while structuring the recent mathematics curriculum in Turkey. The mathematics program, which was renewed in 2018 ultimately, focused on the development of students' mathematical literacy, the correct use of the meaning and language of mathematics, reasoning, estimation, making associations, recognizing the relationship between mathematics and art and valuing mathematics. In line with these goals, significant changes were made in the content of the curriculum (learning domains and learning outcomes), the emphasized in-class teacher-student roles, teaching methods, materials and measurement-evaluation methods (Bozkurt, Küçükakın & Öksüz, 2021). Many academic studies were carried out to show the effectiveness of these changes and updates and how the stakeholders in the teaching process were affected by these changes. For instance, some studies examined the primary and secondary school mathematics curricula by considering the criteria in the TIMSS exam (Delil, Özcan & Işlak, 2020; İncikabı, Mercimek, Ayanoğlu, Aliustaoğlu & Tekin, 2016; Kılıç, Aslan-Tutak & Ertaş, 2014).

The study conducted by İncikabı et al. (2016) evaluated the learning outcomes in the secondary school mathematics curriculum according to the TIMSS 2015 cognitive domain criteria before the 2018 update of the Ministry of National Education. According to the study, the knowing domain was mostly observed in the 5th grade learning outcomes, the applying domain was found the most in the 7th grade curriculum, and reasoning domain was more dominant in the 6th grade. In their study at the secondary school level, Kılıç et al. (2014), on the other hand, determined that the 5th grade learning outcomes in both the 2009 and 2013 curricula are predominantly in the cognitive domain of reasoning. While the 2009 curriculum focused on the cognitive domain of reasoning in the 6th and 8th grade learning outcomes, it was observed that this weight shifted to the applying cognitive domain in the 2013 curriculum. On the other hand, while the learning outcomes at the 7th grade focused on the applying cognitive domain in the 2009 curriculum, the reasoning cognitive domain made up most of the acquisitions in the 2013 curriculum. Delil et al. (2020) evaluated the learning outcomes in the 2018 primary school mathematics curriculum according to TIMSS 2019 cognitive domain and content domains and determined that 58% of all the learning outcomes were in knowing, 32% in applying and 10% in reasoning. In addition, it was observed that the number of learning outcomes at the level of knowing decreased, while the number of acquisitions at the reasoning level increased as students moved from the 1st to 4th grade.

The obtained data show that some countries participating in TIMSS exams are more successful when they adapt their mathematics curriculum according to TIMSS cognitive domains (Delil et al., 2020). From this point of view, it is believed that it is significant to examine the compatibility of the learning outcomes in the curriculum with the TIMSS framework.

This research aimed to examine the learning outcomes in the secondary school mathematics curriculum according to the grade level and learning areas, taking into account the TIMSS cognitive domain skills. The research problem and sub-problems are as follows.

What is the distribution of the learning outcomes in the secondary school mathematics curriculum according to TIMSS cognitive domain skills?

I. What is the distribution according to the grade level when the learning outcomes in the secondary school mathematics curriculum are examined in terms of TIMSS cognitive domain skills?

II. What is the distribution according to learning domains when the learning outcomes in the secondary school mathematics curriculum are examined in terms of TIMSS cognitive domain skills?

Method

Research Model and Data Sources

Qualitative research methods were adopted in this study and document analysis was performed. Documents are subjected to in-depth analysis in order to answer the research problem in document analysis, (Yıldırım & Şimşek, 2013). The data of this research consisted of the Secondary School (5th, 6th, 7th and 8th Grades) Mathematics Curriculum published by the Board of Education and Discipline in 2018 and the cognitive domains included in the TIMSS 2019 mathematics framework.

Data Analysis

Descriptive analysis was used in the analysis of the data. While analyzing the data, the achievements in the fifth grade number learning domain were coded first by both researchers according to the TIMSS cognitive domain levels. Then, these codings were compared and the percentage of agreement was calculated. Initially, the percentage of agreement between encoders was 77% (Miles & Huberman, 1994) for learning outcomes in regards to numbers. After working on some outcome classifications together, the researchers categorized all outcomes independently of each other. The researchers came together again for the differences that emerged in the coding, which were discussed until a consensus was reached. The final agreement rate among encoders was 92%. Considering this rate as sufficient for the study, 215 achievements in the program were categorized according to grade level and learning domains.

According to TIMSS 2019, the cognitive domain is divided into three as knowing, applying and reasoning. Each cognitive domain is divided into sub-dimensions within itself. Table 1 presents the explanations of the cognitive domains used in coding and included in the TIMSS 2019 mathematics framework.

Table 1. *Cognitive domains according to TIMSS 2019 (Mullis & Martin, 2017)*

Knowing	Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).
	Classify/order	Classify numbers, expressions, quantities, and shapes by common properties.
	Compute	Carry out algorithmic procedures for +, –, ×, ÷, or a combination of these with whole numbers, fractions, decimals, and integers. Carry out straightforward algebraic procedures.
	Retrieve	Retrieve information from graphs, tables, texts, or other sources.
	Measure	Use measuring instruments; and choose appropriate units of measurement.
	Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).
Applying	Determine	Determine efficient/appropriate operations, strategies, and tools for solving problems for which there are commonly used methods of solution.
	Represent/Model	Display data in tables or graphs; create equations, inequalities, geometric figures, or diagrams that model problem situations; and generate equivalent representations for a given mathematical entity or relationship.
	Implement	Implement strategies and operations to solve problems involving familiar mathematical concepts and procedures
Reasoning	Analyze	Determine, describe, or use relationships among numbers, expressions, quantities, and shapes. .
	Synthesize	Link different elements of knowledge, related representations, and procedures to solve problems.
	Evaluate	Evaluate alternative problem solving strategies and solutions
	Draw Conclusions	Make valid inferences on the basis of information and evidence.
	Generalize	Make statements that represent relationships in more general and more widely applicable terms.
	Justify	Provide mathematical arguments to support a strategy or solution.

Table 2 presents the sample codings in which the learning outcomes in the secondary school mathematics curriculum are classified according to the TIMSS cognitive domains.

Table 2. *Sample outcomes by cognitive domains*

Knowing	Recall	M.6.3.3.1. Recognize the center, radius and diameter by drawing a circle.
	Recognize	M.6.1.4.1. Recognizes integers and displays them on the number line.
	Classify/order	M.6.1.4.2. Compares and sorts integers.
	Compute	M.6.1.1.2. Performs four operations with natural numbers, taking into account the operation priority.
	Retrieve	-
	Measure	M.6.3.3.2 Determines that the ratio of a circle's length to its diameter is a constant value by measuring.
Applying	Determine	M.5.1.2.7. Determines and uses the appropriate strategy in mental multiplication and division with natural numbers.
	Represent/Model	M.8.3.2.3. Creates the image of polygons resulting from translations and reflections.
	Implement	M.7.1.5.4. Solves percentage problems.
Reasoning	Analyze	M.6.3.5.2. Relates liquid measuring units with volume measuring units.
	Synthesize	M.6.1.6.1. Relates the concept of fraction to division operation.
	Evaluate	M.5.1.4.2. Solves and sets up problems that require addition and subtraction with fractions whose denominators are equal or one multiple of the other's denominator.
	Draw Conclusions	M.8.5.1.3. Explains that the probability value of each output is equal in events with equal chance and this value is 1/n.
	Generalize	M.7.2.1.3. Expresses the rule of the number patterns with a letter, finds the desired term of the pattern whose rule is expressed with a letter.
	Justify	-

There are a total of 215 learning outcomes in the curriculum; 56 for the 5th grade, 59 for the 6th grade, 48 for the 7th grade and 52 for the 8th grade. However, examination of these learning outcomes showed that some of the learning outcomes were found in more than one cognitive domain. For example, related to the learning outcome "Forms the Pythagorean relation and solves the related problems", the idea that the students will obtain the Pythagorean relation by making inferences based on knowledge and evidence was determined as the level of inference, while solving the related problems was determined as the applying level. In this case, the outcome includes both levels. Hence, while there are 215 learning outcomes in the curriculum, a total of 268 learning outcomes statements were categorized in this study. The explanations provided under the learning outcomes were taken into account while determining the cognitive domain of the learning outcomes but these explanations were not included in the classification. Sample learning outcomes for each step are provided in the table above. Since no learning outcomes were found for retrieval and justification steps, these steps were left blank in the table. While determining the learning outcomes, the classification was made by taking into account what the student knew before and what he had to know/do in order to achieve this outcome. For example, for the acquisition of 'drawing a circle to recognize its centre, radius and diameter' in the recall step, the student must first remember the circle. Therefore, this achievement is considered in both recall and recognition categories.

Findings

Findings Regarding the Distribution of TIMSS Cognitive Domain Skills by Grade Level

Table 3 presents the classification of the learning outcomes in the mathematics curriculum according to the TIMSS cognitive domain skills based on the grade level. While creating the table, the learning outcomes at each grade level were matched with the relevant cognitive domain(s). The frequency of cognitive domains at a specific grade level is shown as a percentage.

Table 3. *Distribution of learning outcomes at each grade level according to TIMSS-2019 cognitive domain skills*

Cognitive Domains	Sub Dimensions	Grade Level				Grand Total
		5th Grade f(%)	6th Grade f(%)	7th Grade f(%)	8th Grade f(%)	
Knowing	Recall	1 (1,3)	1 (1,4)	2 (3,1)	0 (0)	4 (1,4)
	Recognize	16 (21,9)	5 (7)	1 (1,5)	8 (13,3)	30 (11,1)
	Classify/Order	5 (6,8)	2 (2,8)	1 (1,5)	0 (0)	8 (2,9)
	Compute	18 (24,6)	2 (2,8)	6 (9,5)	3 (5)	29 (10,8)
	Retrieve	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Measure	3 (4,1)	1 (1,4)	0 (0)	0 (0)	4 (1,4)
	Total	43 (58,9)	11 (15,4)	10 (15,8)	11 (18)	75(27,9)
Applying	Determine	12 (16,4)	5 (7)	8 (12,6)	5 (8,3)	30 (23,2)
	Represent/Model	3 (4,1)	6 (8,4)	7 (11,1)	13 (21,6)	29 (22,4)
	Implement	9 (12,3)	27 (38)	23 (36,5)	11 (18,3)	70 (54,2)
	Total	24 (32,8)	38 (53,5)	38 (60,3)	29 (47,5)	129(48,1)
Reasoning	Analyze	5 (6,8)	13 (18,3)	8 (12,6)	13(21)	39 (14,5)
	Synthesize	0 (0)	6 (8,4)	4 (6,3)	5 (8,3)	15 (5,5)
	Evaluate	1 (1,3)	0 (0)	0 (0)	1 (1,5)	2 (0,3)
	Draw Conclusions	0 (0)	3 (4,2)	2 (3,1)	2 (3,3)	7 (2,6)
	Generalize	0 (0)	0 (0)	1 (1,5)	0 (0)	1 (0,3)
	Justify	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Total	6 (8,2)	22 (30,9)	15 (23,8)	21 (34)	64(23,8)
	Grand Total	73 (27,2)	71 (26,4)	63(23,5)	61(22,7)	268 (100)

As Table 3 shows, a total of 268 learning outcomes were evaluated at all grade levels. The distribution of these learning outcomes according to TIMSS-2019 cognitive domains was as follows: 27%. 9 (f=75) knowing, 48.1% (f=129) applying and 23.8% (f=64) reasoning. Recognize and Compute sub-dimensions of Knowing were found to constitute approximately 80% of the learning outcomes. There were no learning outcomes in the sub-dimension of Recall. In the applying domain, the sub-dimension of Implement constituted 54.2% (f=70) of the learning outcomes. Determine and Represent/Model sub-dimensions constituted 45.6% of the Implement sub-dimension with approximately the same percentage. The reasoning domain comprised 23.8% (f=64) of the total learning outcomes. The Analyze sub-dimension (f=39) was the most common learning outcomes in the domain of reasoning. On the other hand, there were no learning outcomes for the Justify sub-dimension.

The fifth grade learning outcomes examined according to TIMMS cognitive domain skills were 73 in total. These learning outcomes were the most concentrated in the domain of knowing with a rate of 58.9%. Applying was included in the program at a rate of 32.8% and reasoning at a rate of 8.2%. When the sub-dimensions of the learning outcomes were examined, it was seen that the most learning outcomes are in the Compute and Recognize sub-dimensions, similar to the general outlook. These sub-dimensions were followed by the Classify/Order (6.8%) sub-dimension. While Measure was represented by 4.1% and Recall by 1.3%, there were no learning outcomes at the level of Retrieve. Determine sub-dimension (16.4%) was the most represented sub-dimension in the applying domain followed by Implement (12.3%) took place. The least represented sub-dimension at this grade level was Represent/Model (4.1%). The reasoning domain was generally the least represented cognitive domain (8.2%) at the Grade 5 level. Among the existing learning outcomes, it was the most represented in the Analyze sub-dimension (6.8%). Evaluate sub-dimension was represented with only 1 outcome (1,3). There were no learning outcomes in the sub-dimensions of Synthesize, Draw Conclusions, Generalize and Justify.

Examination of the learning outcomes at the sixth grade level showed that there were 71 learning outcomes in total. These learning outcomes were in the domain of applying with a rate of 53,5% the most followed by the reasoning domain with 30,9%. The least number of learning outcomes was in the domain of knowing (15,4%). When the learning outcomes were evaluated in terms of their distribution to the sub-dimensions, similar to the general outlook, the Impalement sub-dimension of the applying cognitive domain was the most represented learning outcome in the program with a representation rate of 38%. This was followed by the Analyze sub-dimension (18,3%) in the reasoning domain. Represent/Model and Synthesize were 8,4% at the relevant grade level; Recognize and Determine were represented by 7%. In addition, it was seen that the number of learning outcomes related to the sub-dimensions of Recall, Classify/order, Compute, Measure and Draw Conclusions was quite low. Similar to the fifth grade level, there were no learning outcomes in Retrieve, Generalize and Justify. In addition, the Evaluate sub-dimension, represented by 1 learning outcome in the 5th grade, had no related learning outcomes at the 6th grade level.

There were 63 learning outcomes in the 7th grade. These learning outcomes overlapped with the applying domain (60,3%) the most. Reasoning made up 23,8%, and knowing made up 15,8% of the learning outcomes. Similar to the general outlook, the sub-dimension of Implement (36.5%) had the most learning outcomes. The domain of reasoning had learning outcomes mostly related to Analyze (12.6%). In the domain of knowing, Compute (9.5%) was the most common sub-dimension. There were

very few gains in sub-dimensions such as Recall, Recognize, Classify/order, Synthesize, Draw Conclusions, and Generalize while there were no learning outcomes in the sub-dimensions of Retrieve, Measure, Evaluate and Justify. Examination of the 8th grade learning outcomes pointed to 61 learning outcomes in total. The remarkable point was the fact that applying constituted approximately half of the learning outcomes in the cognitive domain in the distribution. The least number of learning outcomes was identified in the knowing domain. The reasoning domain had a distribution of 34%. When all of the sub-dimensions were examined, the sub-dimensions of Analyze, Represent/Model, Implement and Recognize were found to be prominent. On the other hand, it was determined that there were no learning outcomes in the sub-dimensions of Recall, Classify/order, Retrieve, Measure, Generalize and Justify.

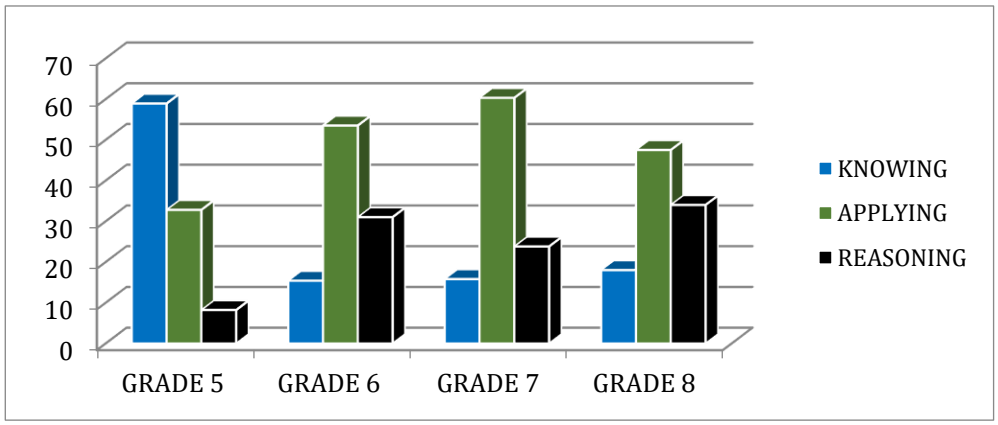

Figure 1. Distribution of cognitive domains of TIMSS by grade level (%)

Figure 1 presents the distribution of the learning outcomes associated with the TIMSS-2019 cognitive domains by grade levels as a percentage. It was observed that the learning outcomes at the knowing level were mostly at the fifth grade level (58,9%), while it constituted fifteen percent of all learning outcomes at the other grade levels. The applying cognitive domain, which corresponded to the highest learning outcomes among all levels, was represented the most at the 7th grade level. The ratio of learning outcomes at the applying level was close to each other at all grade levels except for the fifth grade. The cognitive domain of reasoning was observed the least at the fifth grade and the most at the eighth grade. In addition, it is observed that the ratio of learning outcomes corresponding to the level of reasoning increased with the grade level. While this rate was 8% at the fifth grade level, it was 30% in the sixth grade, 24% in the seventh grade and approximately 34% in the eighth grade.

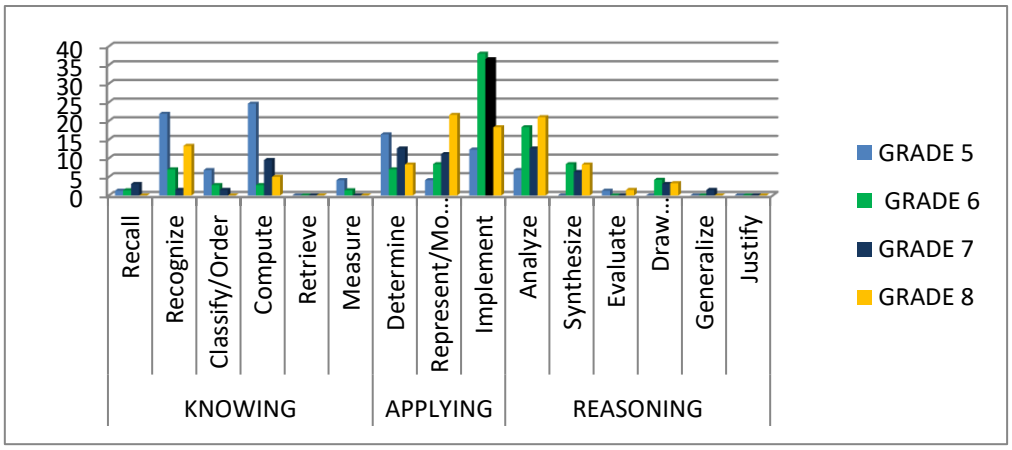

Figure 2. Distribution of sub-dimensions in TIMSS cognitive domains by grade level (%)

Figure 2 presents the distribution of the learning outcomes in the mathematics program according to the sub-dimensions of TIMSS cognitive domains at the grade level. The sub-dimensions of Recognize, Compute, Determine, Represent/Model, Implement and Analyze were weightrf in the distribution of learning outcomes.

Findings Regarding the Distribution of TIMSS Cognitive Domain Skills by Learning/Content Domains

Secondary School Mathematics Curriculum consists of five learning domains: Numbers and Operations, Algebra, Geometry and Measurement, Data Processing, and Probability. In the domain of Numbers and Operations, the concept of percentage, operations on natural numbers, fractions, integers, ratio-proportion, basic level sets, exponential numbers, radical numbers, rational and irrational numbers are taught. Learning outcomes related to algebra learning domain first start in the 6th grade and include number patterns, algebraic expressions, properties of equality and equations, first-order equations with one unknown and inequalities. In the Geometry and Measurement domain, the subjects of line, line segment, ray, polygons, length and area measurement, circle, prism, angles, geometric objects, prisms and transformation geometry are covered. The learning outcomes related to Data Processing start in the 5th grade and students are expected to create research questions that require data collection, to represent and interpret the data appropriate to these questions with tables, frequency tables and column charts. In addition, there are learning outcomes related to the calculation and interpretation of mean, median and peak value concepts and line and circle graphics. Probability learning domain is covered only in 8th grade. At this level, students are expected to identify possible situations and events with different probabilities, examine events with equal probability, and calculate the probabilities of simple events. Table 4 provides the distribution of learning outcomes in each learning domain in the 2018 secondary school mathematics curriculum according to TIMSS 2019 cognitive areas. The learning outcomes in each learning domain were associated with the cognitive domain and its sub-dimensions according to the learning domains. The data in the table were represented as frequency and percentage.

Table 4. *Distribution of learning domains in secondary school mathematics curriculum according to TIMSS cognitive domains*

Cognitive Dmains	Sub Dimensions	Numbers and Operations f (%)	Algebra f (%)	Geometry and Measurement f (%)	Data Processig f (%)	Probability f (%)	Total f (%)
Knowing	Recall	2 (1,7)	0	2 (1,8)	0	0	4 (1,4)
	Recognize	15 (12,9)	2 (7,6)	13 (12,1)	0	0	30(11,1)
	Classify/ order	5 (4,3)	0	3 (2,8)	0	0	8 (2,9)
	Compute	23 (19,8)	1 (3,8)	5 (4,6)	0	0	29(17,2)
	Retrieve	0 (0)	0	0 (0)	0	0	0 (0)
	Measure	0 (0)	0	4 (3,7)	0	0	4 (1,4)
	Total	45 (38,7)	3 (11,5)	27 (25,2)	0	0	75(27,9)
Applying	Determine	14 (12)	1 (3,8)	12 (11,2)	1(7,1)	2 (40)	30(11,1)
	Represent/ Model	4 (3,4)	7 (26,9)	15 (14)	3(21)	0	29(17,2)
	Implement	40 (34,5)	6 (23)	20 (18,6)	3 (21)	1 (20)	70(26)
	Total	58 (50)	14(53,)	47 (43,9)	7(50)	3 (60)	129(48)
Reasoning	Analyze	11 (9,4)	7(26,9)	18 (16,8)	3 (21)	0	39(14,5)
	Synthesize	1 (0,8)	1 (3,8	11 (10,2)	1 (7,1)	1 (20)	15(5,5)
	Evaluate	1 (0,8)	0	0 (0)	1 (7,1)	0	1(0,3)
	Draw Conclusions	0 (0)	0	4 (3,7)	2 (14,2)	1 (20)	7(2,6)
	Generalize	0 (0)	1 (3,8)	0 (0)	0	0	1(0,3)
	Justify	0 (0)	0	0 (0)	0	0	0(0)
	Total	13 (11,2)	9(34,6)	33 (30,8)	7 (50)	2 (40)	64(23,8)
	Grand Total	116 (100)	26 (100)	107(100)	14(100)	5(100)	268(10)

Looking at the program in general, it can be argued that the learning outcomes were mostly in the learning domains of Numbers and Operations and Geometry and Measurement Algebra and Data Processing learning domains constituted approximately 15% of the program; Probability learning domain was included in the program at a rate of about 2%.

Examination of the cognitive levels of the learning outcomes in each learning domain showed that 39% of the 116 learning outcomes in the learning domain of numbers were at the level of knowing, 50% at the level of applying and 11% at the level of reasoning. In the sub-dimensions, it was determined that half of the learning outcomes in the number learning domain were associated with the Implement sub-dimension of the applying cognitive domain. It was seen that the Compute and Recognize sub-dimensions in the knowing cognitive domain constituted the majority of the learning outcomes. On the other hand, no learning outcomes were associated with the sub-dimensions of Retrieve and Measure. It can be argued that Implement and Determine sub-dimensions were most prominent in the applying cognitive domain. The Analyze sub-dimension was most dominant in the reasoning cognitive domain. While Synthesize and Evaluate sub-dimensions were included at low levels, there were no learning outcomes in the sub-dimensions of Draw Conclusions, Generalize and Justify.

In Algebra learning domain, the applying cognitive domain was included the most while the knowing cognitive domain was included the least. Recognize and Compute were given little place in the cognitive domain of knowing and there were no learning outcomes in Classify/order and Retrieve and Measure sub-dimensions. The sub-dimensions of Represent/Model and Implement were predominant in the applying cognitive domain. The sub-dimension of Determine was included very little. In the

reasoning cognitive domain, Analyze sub-dimension stood out as it constituted the majority of the learning outcomes. While Synthesize and Generalize were included very little, there were no learning outcomes in Evaluate, Draw Conclusions and Justify sub-dimensions

Of the 107 learning outcomes in Geometry and Measurement, 25.2% of the learning outcomes were at the level of knowing, 43.9% at the level of applying and 30.8% at the level of reasoning. There were some differences in terms of sub-dimensions. According to the distribution with a more homogeneous structure compared to other learning areas, the sub-dimensions of Recognize (12.1%) in the knowing cognitive domain, Implement in the applying cognitive domain (18.6%) and Analyze in the reasoning cognitive domain (16.8%) were the most prominent. No learning outcomes were found in the sub-dimension of Retrieve in the knowing cognitive domain, and in the sub-dimensions of Evaluate, Generalize and Justify in the reasoning cognitive domain.

It can be argued that the distribution of learning outcomes in Data Processing learning domain differed from the other learning domains. It was noteworthy that there were no learning outcomes in the knowing cognitive domain. Showing a homogeneous distribution, the learning outcomes included the cognitive domains of applying and reasoning. In the applying cognitive domain, the sub-dimension of Represent/Model and Implement were dominant, while the sub-dimension of Analyze was more prominent in the reasoning cognitive domain. Just as in the geometry learning domain, no learning outcomes were found in the Generalize and Justify sub-dimensions in the reasoning cognitive domain.

The distribution of the cognitive levels of the learning outcomes in the probability learning domain was similar to those in data processing learning. There were no learning outcomes in the knowing cognitive domain in this learning domain, and in general, the learning outcomes were the least. There were no learning outcomes in the Represent/Model sub-dimension in the applying cognitive domain. On the other hand, in the reasoning cognitive domain, it was observed that there was one learning outcome each from the Synthesize and Draw Conclusions sub-dimensions. There were no learning outcomes in the sub-dimensions of Analyze, Evaluate, Generalize and Justify.

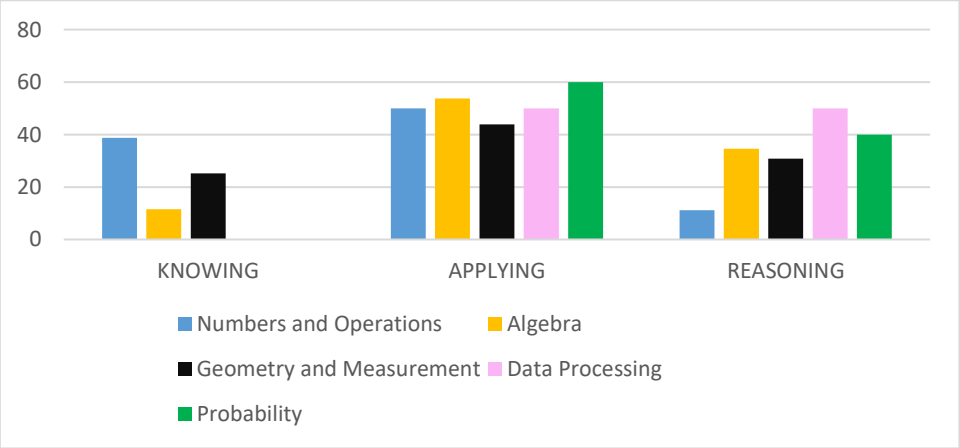

Figure 3. Change of TIMSS 2018 cognitive domains according to mathematics learning domains

Figure 3 shows the change of TIMSS cognitive domains according to the learning domains in the secondary school mathematics curriculum. The cognitive domain of knowing was mostly observed in Numbers and Operations, the cognitive domain of application was mostly seen in the learning domain of Probability, and the cognitive domain of reasoning was found the most in the learning domain of Data Processing.

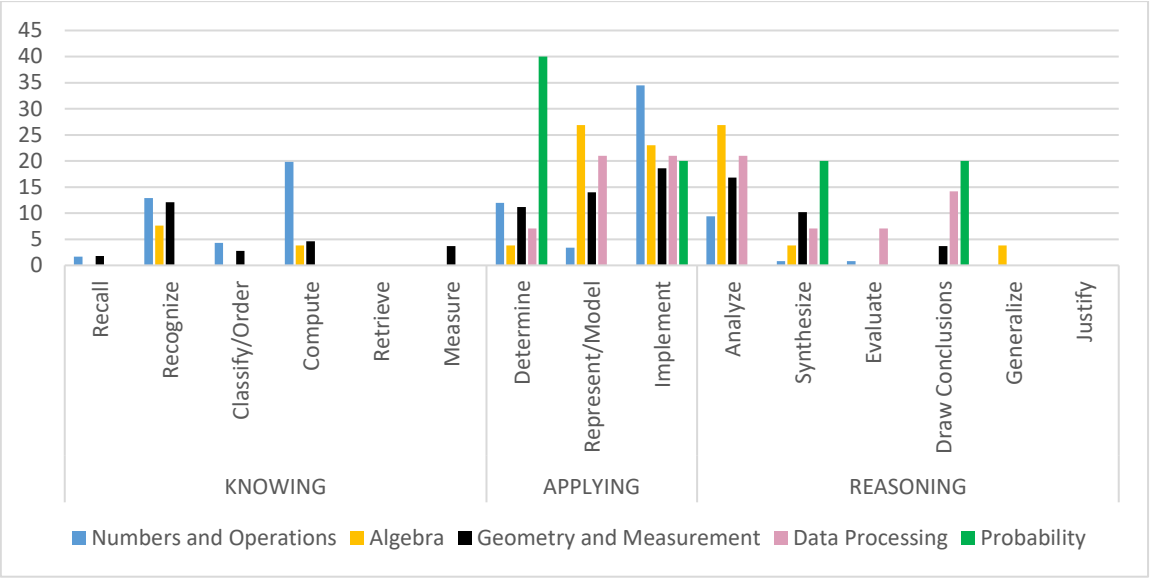

Figure 4. Change of cognitive sub-dimensions according to mathematics learning domains

Figure 4 presents the distribution of cognitive sub-dimensions within the learning outcomes of each learning domain. In general, the cognitive sub-dimensions of the learning outcomes of each learning domain were found to be concentrated on Recognize, Compute, Determine, Represent/Model, Implement, Analyze, Synthesize and Draw Conclusions sub-dimensions. There were no learning outcomes of any learning domain in the Retrieve and Justify sub-dimensions while a very low rate of learning outcomes were observed in Recall, Classify/order, Measure, Evaluate, and Generalize sub-dimensions.

Regarding the sub-dimensions, the learning outcomes related to the Recall sub-dimension of the knowing cognitive domain were concentrated on Numbers and Operations (12,9%) and Geometry and Measurement (12,1%). The Compute sub-dimension were mostly related to Numbers and Operations (19,8%) while Algebra (3,8%) and Geometry and Measurement (4,6%) learning domains were close to each other and less frequent in this dimension. There were very few learning outcomes in the areas of Numbers and Operations (1,7%) and Geometry and Measurement (1,8%) in the Recall sub-dimension. In the cognitive sub-dimension of Measure, there were few (3,7%) learning outcomes only in the domain of Geometry and Measurement. There were no learning outcomes related to this step related to Retrieve sub-dimension.

Based on the examination of the learning outcomes in the curriculum in general, it was determined that the learning domains in the applying cognitive domain had a close distribution and constituted approximately half of the learning outcomes. There were learning outcomes belonging to all learning domains in the Determine sub-dimension. In this sub-dimension, Probability learning domain stood out with the high level of learning outcomes. In the Represent/Model sub-dimension, Algebra and Data Processing learning domains were more prominent followed by Geometry and Measurement learning domain. Although there were very few learning outcomes regarding the Numbers and Operations learning domain, there were no learning outcomes in the Probability learning domain. A homogeneous distribution was striking in the Implement sub-dimension. While the most learning outcomes were found in the field of learning Numbers and Operations and Algebra, the least learning outcomes were observed in the Probability learning domain.

Looking at the sub-dimensions of the reasoning cognitive domain, it can be argued that the learning outcomes were concentrated in the Analyze sub-dimension. The Analyze sub-dimension had the highest rate in Algebra (34,4%) followed by Data Processing (21%), Geometry and Measurement (16,8%), and Numbers and Operations (9,4%). There were no learning outcomes in the Probability learning domain. In the Synthesize sub-dimension, Probability and Geometry and Measurement learning domains were prominent. In Draw Conclusions sub-dimension, as in the Synthesize sub-dimension, there were learning outcomes in Data Processing learning domain in addition to Probability and Geometry and Measurement learning domains. In the Evaluate sub-dimension, very few learning outcomes were found in the Numbers and Operations and Data Processing learning domains. Similarly, in the Generalize sub-dimension, there were only a small number of learning outcomes related to Algebra learning domain. There were no learning outcomes in any learning domain in the Justify sub-dimension.

Discussion and Conclusion

This study which explored the learning outcomes in the 2018 secondary school mathematics curriculum according to TIMSS-2019 cognitive domain skills determined that 28% of the learning outcomes were at the level of knowing, 48% at the level of applying, and 24% at the level of reasoning. When the distribution of the questions used in the TIMSS 2019 exam was examined according to cognitive domains, it was concluded that 35% of the 8th grade questions were at the level of knowing, 40% were at the level of applying and 25% at the level of reasoning (Mullis & Martin, 2017). Accordingly, it can be argued that based on TIMSS, the program included the cognitive domain of knowing and reasoning at lesser levels while it included the cognitive domain of applying at higher levels. Examination of the studies conducted abroad showed that the learning programs of the countries with lower achievement in TIMSS had low cognitive levels. For example, Ndlovu & Mji (2012) reported that not enough attention was paid to aligning the South African mathematics curriculum with TIMSS assessment frameworks in terms of cognitive level definitions. Puncova & Valentova (2020) examined the achievements in the field of data analysis learning in the mathematics curriculum of Singapore, which had a high achievement in TIMSS, and Slovakia, which had a lower level achievement. As a result, it was concluded that Slovakia's achievements lagged far behind Singapore in terms of cognitive level. The present study also concluded that shifting the content of the achievements towards the reasoning level could positively affect academic achievement in the following years.

Based on the evaluation conducted in terms of grade level, it was determined that the learning outcomes for knowing – applying – reasoning in the fifth grade were 58,9%, 32,8% and 8.2%, respectively. In their study where they evaluated the learning outcomes in the Primary School Mathematics Curriculum, Delil, Özcan, and Işık (2020) reported that 58% of all learning outcomes were at the level of knowing, 32% at the level of applying, and 10% at the level of reasoning. Similarly, comparing Irish and Turkish primary school mathematics curricula, Çil (2022), reported that approximately 62% of the primary school learning outcomes of the program in Turkey were at the level of knowing. Considering the result obtained from the present study, it can be argued that the learning outcomes at the level of knowing were dominant for the 5th grade, as in the primary school curriculum. Considering that the fifth grade is the year when secondary school is just started and the foundation of secondary school information is laid, it is normal to have learning outcomes similar to the primary school curriculum. This was also reported by İncikabı et al., (2016) who analyzed the 2013 mathematics

curriculum and by Kılıç, Tutak and Aktaş (2014) who examined the 2009 mathematics curriculum. As a matter of fact, these studies concluded that the learning outcomes at the level of knowing were predominant in the fifth grades in the mathematics curriculum published in 2009 and 2013.

Examination of the learning outcomes in the sixth grade showed that the learning outcomes at the level of knowing were 15,4%, at the level of applying were 53,5% and at the level of reasoning were 30,9%. It was observed that most of the knowledge-based learning outcomes since primary school years switched to implementation with a very sharp transition in the sixth grade. Moreover, the learning outcomes for reasoning, which did not reach 10% in the fifth grade, increased to 30% as well. This sharp transition can have a negative impact on students. Instead, learning outcomes at the level of applying and reasoning should be included at an adequate level starting from primary school. İncikabı, Özgelen Tjoe (2012) examined the distribution of numbers and biology subject domains in the Turkey and USA curricula, since these learning domains created the biggest difference in the TIMSS results of both countries. They reported that the learning outcomes levels were different in terms of both grade level and cognitive field level, and that these differences may affect success.

It was determined that 60% of the learning outcomes included applying cognitive domain in the seventh grade, Reasoning made up 23,8%, and knowing made up 15i8% of the learning outcomes. When the seventh grade learning outcomes were examined, it was seen that the students were geared to solve problems related to the mathematical subjects and concepts they learned. In this context, it is normal to focus on applying. The 8th grade learning outcomes had similar applying and reasoning rates, while knowing remained at only 10%. The studies examining the 2013 and 2009 curricula concluded that the learning outcomes related to the knowing were higher both in the 7th and 8th grades (İncikabı et al., 2016; Kılıç, Tutak & Aktaş, 2014). In this direction, the examination of the 2019 TIMSS report showed that Turkey achieved higher scores compared to previous years, and that the achievement in reasoning questions increased especially in mathematics lessons (TIMSS, 2019). This result may be one of the positive results of shifting the learning outcomes to the level of reasoning.

On the other hand, it is expected that students who have completed the learning outcomes at the applying and reasoning level and who have completed the 8th grade will be able to easily solve routine and non-routine problems related to the mathematics that they have learned so far. In this direction, examination of the Central Examination Report for Secondary Education Institutions (MoNE, 2022) published by the Ministry of National Education in 2022 shows that the average of correct answers in the 20-question mathematics test of the students who took LGS (High School Entrance Exam) in 2022 was 4,74. Considering that approximately 85% of 8th grade students participate in LGS (MEB, 2022), it can be argued that LGS gives more accurate results than TIMSS about the general condition of all students. It is also known that the LGS results for 2019 and 2020 were similar (MEB, 2022). Hence, how the learning outcomes in the program are reflected in the classroom environment should be explored. For example, studies reporting the analysis of the questions in the textbooks prepared in line with these learning outcomes based on the cognitive level reported that the majority of these questions are based on the level of knowing-applying, and the number of questions at the level of reasoning is not sufficient (Tutak & Farımaz, 2022; Taşpınar Şener & Bulut, 2022; Yılmaz, Ay &Aydin, 2021). For example, Yılmaz, Ay, and Aydın (2021) reported that the questions in the textbooks on Data Processing learning domain are related to the applying cognitive domain, but that the learning outcomes are weighted on the level of reasoning. Yakar (2020) examined the secondary school 5th Grade Mathematics Textbook, the

curriculum objectives and whether the learning outcomes were consisted with the explanations of the outcomes. Accordingly, it was determined that some of the program outcome or outcome explanations were not included at all in the course book, and some of them were not addressed properly. Taşpınar Şener and Bulut (2022) reported that the number of questions at the level of reasoning in the 8th grade mathematics textbook was insufficient and suggested that the objectives should also be revised since the textbooks are developed by taking into account the learning outcomes in the curriculum. However, the present study found that the learning outcomes at the 8th grade reasoning level were already high. In their study, Taşpınar Şener and Bulut (2022) reported that the way of presenting the units in the textbook is not arranged in such a way that the students can interpret and draw conclusions on their own, and the 'show and do' technique is adopted, with each step given in the book. In this case, even if the learning outcomes were at the level of reasoning, their reflection in the books may have been different. Therefore, the way the textbooks deal with the learning outcomes becomes more important. From this point of view, it is thought that there is a need for studies that explain how the learning outcomes at the analysis level are handled in the textbook. Güzel, Bozkurt, and Özmantar (2020) reported that the aims of the activities in the textbooks were perceived differently by the teachers and that different cognitive levels emerged. Therefore, it is an important issue how teachers perceive the learning outcomes in the curriculum and how they reflect it to the classroom environment.

Examination of the sub-dimensions of knowing, applying and reasoning levels showed that the highest number of learning outcomes in the knowing cognitive domain were at the level of Compute and Recognize. To reach levels of applying and reasoning, students need to be familiar with mathematical operating procedures and be fluent in calculations. It is important to be able to do certain basic calculations to solve all types of problems (Mullis & Martin, 2017). In this context, it is natural to have higher number of learning outcomes at these levels. As a matter of fact, a similar result was found in the 2013 curriculum (İncikabi et al., 2017). In the applying cognitive domain, the highest number of learning outcomes was in Implement sub-dimension followed by Represent/Model. In general, when the learning outcomes in applying were examined, it was found that some learning outcomes required solving problems by using existing knowledge. The problems used in TIMSS exams can be from real life situations, as well as from algebraic expressions, functions, equations, geometry or all mathematics topics in statistics (Mullis & Martin, 2017). This study demonstrated that there are learning outcomes at the level of applying for all learning domains (Numbers and Operations, Algebra, Geometry and Measurement, Data Processing, and Probability) which is parallel to TIMSS practice. Within the reasoning domain, the learning outcomes are concentrated at the Analyze level. Although learning outcomes were found at the analysis level of all the examined grades, the highest rate was found in the 8th grade. As the cognitive levels of the students increase, they should encounter high-level learning outcomes. At the same time, it is desirable that this level is high in terms of associating students with the mathematical knowledge they have learned. Learning outcomes at the Synthesize level were also found in the 6th, 7th and 8th grades. The number of other learning outcomes in reasoning is extremely few. Doğan (2020) examined the learning outcomes in the Primary School Mathematics Curriculum according to the solo classification, and similarly stated that the learning outcomes for the students should include the learning outcomes that appeal to higher level mental skills. Learning outcomes at the level of evaluation and generalization are especially needed. As a matter of fact, previous studies showed that the students cannot even make appropriate evaluations about their own problem solutions (Deringöl, 2006; Gökkurt, Örnek, Hayat & Soylu, 2015). In addition, one of the important skills that

students should acquire during the transition from arithmetic to algebra and even in the pre-algebra period is the skill of generalization (Baki, 2008; Kaput, 1998). However, students have difficulties in the process of generalizing their problem solutions (Baştürk, 2021). In this context, it is important that the learning outcomes at all levels in the cognitive domain of reasoning should be incorporated at the secondary school level.

Recommedations

Compared to TIMSS, the secondary school curriculum in Turkey addressed the cognitive domain of knowing and reasoning at lower rates while it included the cognitive domain of applying at higher rates. In this direction, it is thought that it would be beneficial to revise the program in a way to include cognitive domains in a more balanced way. In addition, the findings obtained in this study brought to mind the question of how the learning outcomes are actually reflected in the classroom environment. In this context, studies can be conducted to reveal how the learning outcomes at the reasoning level are addressed in the textbooks. In addition, to what extent the teachers reflect these learning outcomes to the classroom environment can be explored by examining the problems and materials prepared by the teachers in line with the learning outcomes.

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Genişletilmiş Türkçe Özet

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Ortaokul Matematik Dersi Öğretim Programı Kazanımlarının TIMSS-2019 Bilişsel Alan Becerisine Göre Analizi

Giriş

Eğitim programı, öğrencilerin önceden belirlenmiş eğitim amaçlarına ulaşabilmesi için uygulanan planlı eğitsel etkinliklerin tümüdür (Başaran & Çınkır, 2013). Eğitim programının en önemli alt programı olarak nitelendirilen öğretim programı ise, eğitim programının amaçları doğrultusunda, bir dersle ilgili olarak sınıf düzeyinde belirlenen hedefleri kazandırmaya yönelik planlanmış, okul içi ve dışını kapsayan tüm etkinlikleri sergileyen yaşantılar düzeneğidir (Kartal & Yazgan, 2016).

Türkiye'de son dönem matematik öğretim programları yapılandırılırken önceki programlardan farklı olarak, öğrenci merkezli bir eğitim anlayışı benimsenmiştir. Son olarak 2018 yılında yenilenen matematik programı öğrencilerin matematiksel okuryazarlıklarının geliştirilmesine, matematiğin anlam ve dilinin doğru bir şekilde kullanımına, akıl yürütme, tahmin etme, ilişkilendirme yapma, matematiğin sanatla olan ilişkisini fark etme ve matematiğe değer verme gibi hedeflere odaklanmıştır. Yapılan bu değişim ve güncellemelerin etkililiği ve öğretim sürecindeki paydaşların bu değişimlerden nasıl etkilendiğini ortaya koymak amacıyla pek çok akademik çalışma yapılmıştır. Örneğin bazı çalışmalarda ilkokul ve ortaokul matematik dersi öğretim programları TIMSS sınavındaki kriterler göz önüne alınarak incelenmiştir (Delil, Özcan & Işlak, 2020; İncikabı, Mercimek, Ayanoğlu, Aliustaoğlu & Tekin, 2016; Kılıç, Aslan-Tutak &Ertaş, 2014). Bu çalışmalardan birisi olan İncikabı ve arkadaşlarının (2016) çalışmasında ortaokul matematik dersi öğretim programındaki kazanımları, Milli Eğitim Bakanlığı'nın 2018 yılı güncellemesinden önce TIMSS 2015 bilişsel alan kriterlerine göre değerlendirmiştir. Çalışmaya göre bilme alan en fazla oranda beşinci sınıf kazanımlarında, uygulama alanı en fazla yedinci sınıf müfredatında, muhakeme alanı ise en fazla altıncı sınıfta yer almıştır.. Delil ve diğerleri (2020) ise 2018 yılı ilkokul matematik dersi öğretim programındaki kazanımları TIMSS 2019 bilişsel alan ve öğrenme alanlarına göre değerlendirmiştir. Bu çalışmada tüm kazanımların %58'i bilme,

%32'si uygulama ve %10'u akıl yürütme basamağında olduğu belirlenmiştir. Ayrıca 1. sınıftan 4. sınıfa doğru gidildikçe bilme düzeyindeki kazanım sayılarının azaldığı, akıl yürütme basamağındaki kazanım sayılarının ise arttığı görülmüştür.

Elde edilen veriler TIMSS sınavlarına katılan bazı ülkelerin matematik öğretim programlarını TIMSS bilişsel alanlarına göre düzenlediklerinde daha başarılı olduklarını göstermektedir (Delil ve diğerleri, 2020). Buradan hareketle öğretim programında yer alan kazanımların TIMSS çerçevesi ile ne kadar uyumlu olduğunun incelenmesinin önemli olduğu düşünülmektedir.

Bu araştırmanın amacı TIMSS bilişsel alan becerileri dikkate alınarak, ortaokul matematik dersi öğretim programındaki kazanımların sınıf düzeyine ve öğrenme alanlarına göre incelemesini yapmaktır. Araştırmanın problemi ve alt problemler aşağıdaki şekildedir.

Ortaokul matematik dersi öğretim programındaki kazanımların TIMSS bilişsel alan becerilerine göre dağılımı nasıldır?

I. Ortaokul matematik dersi öğretim programındaki kazanımlar TIMSS bilişsel alan becerileri açısından incelendiğinde sınıf düzeyine göre nasıl bir dağılım göstermektedir?

II. Ortaokul matematik dersi öğretim programındaki kazanımlar TIMSS bilişsel alan becerileri açısından incelendiğinde öğrenme alanlarına göre nasıl bir dağılım göstermektedir?

Yöntem

Bu çalışmada nitel araştırma yöntemleri benimsenmiş ve doküman analizi yapılmıştır. Verilerin analizinde betimsel analiz kullanılmıştır. Veriler analiz edilirken öncelikle, beşinci sınıf düzeyi sayılar öğrenme alanındaki kazanımlar her iki araştırmacı tarafından TIMSS bilişsel alan seviyelerine göre kodlanmıştır. Daha sonra bu kodlamalar karşılaştırılarak uyum yüzdesi hesaplanmıştır. Kodlayıcılar arasındaki son uyum oranı %92 olmuştur. Bu oranın çalışma için yeterli olacağından hareketle programdaki 215 kazanım sınıf seviyesi ve öğrenme alanlarına göre sınıflandırılmıştır.

Kazanımlar incelendiğinde bazı kazanımların birden fazla bilişsel alanda bulunduğu belirlenmiştir. Örneğin 'Pisagor bağıntısını oluşturur, ilgili problemleri çözer' kazanımında, öğrencilerin Pisagor bağıntısını bilgi ve kanıta dayalı çıkarım yaparak elde edeceği düşüncesi ise sonuç çıkarma düzeyi olarak belirlenirken, ilgili problemleri çözme, uygulama düzeyi olarak belirlenmiştir. Bu durumda, kazanım her iki düzeyi de barındırmaktadır. Bu şekilde müfredatta 215 kazanım ifadesi yer alırken, bu çalışmada toplamda 268 kazanım ifadesi sınıflandırılmıştır. Kazanımların hangi bilişsel alanda bulunduğu belirlenirken kazanımın altında yapılan açıklamalar dikkate alınmıştır ancak bu açıklamalar sınıflamaya dahil edilmemiştir.

Bulgular

Öğretim programı incelendiğinde, toplam 268 tane kazanım bulunduğu tespit edilmiştir. Bu kazanımların TIMSS-2019 bilişsel alanlarına göre dağılımı %27.9 (f=75) bilme, %48.1 (f=129) uygulama ve %23.8 (f=64) akıl yürütme şeklindedir. Alt boyutlardan bilme alanının tanıma ve hesaplama alt boyutunun kazanımların yaklaşık %80'ini oluşturduğu görülmektedir. Bilgi alma alt boyutunda ise hiçbir kazanımın olmadığı belirlenmiştir. Uygulama alanında ise uygulama alt boyutu kazanımların %54,2 (f=70)'sini oluşturmaktadır. Diğer alt boyutlardan karar verme ve sunma-modelleme alt boyutları yaklaşık olarak aynı yüzdelikle uygulama alt boyutunun %45,6'sını

oluşturmaktadır. Akıl yürütme alanı toplam kazanımların %23,8 (f=64)'ini oluşturmuştur. Analiz alt boyutu (f=39) akıl yürütme alanında en çok karşılaşılan kazanım olmuştur. Buna karşın doğrulama alt boyutunu karşılayan kazanım bulunmamaktadır.

TIMMS bilişsel alan becerilerine göre incelenen beşinci sınıf kazanımları toplam 73'tür. Bu kazanımların en fazla %58,9 oranıyla bilme alanında yer aldığı görülmektedir. Uygulama %32,8 oranında, akıl yürütme ise % 8,2 oranında programda yer almıştır. Kazanımların alt boyutlarına bakıldığında ise genel görünüme benzer şekilde en çok kazanımın hesaplama ve tanıma alt boyutlarında olduğu görülmektedir. Bu alt boyutları sıralama-sınıflama (%6,8) alt boyutu takip etmektedir. Ölçme %4,1, hatırlama %1,3 oranında temsil edilirken bilgi alma düzeyinde hiçbir kazanımın olmadığı görülmektedir. Uygulama alanında karar verme alt boyutu (%16,4) en çok temsil edilen alt boyuttur. Karar vermeden sonra uygulama alt boyutu (%12,3) yer almıştır. Bu sınıf seviyesinde en az temsil edilen alt boyut ise sunma-modelleme (%4,1) olmuştur. Akıl yürütme alanı genel olarak 5. sınıf seviyesinde en az temsil edilen bilişsel alandır (%8,2). Var olan kazanımlardan en fazla analiz alt boyutunda temsil edilmiştir (%6,8). Değerlendirme alt boyutu yalnızca 1 kazanımla (1,3) temsil edilmiştir. Sentez, sonuç çıkarma, genelleme ve doğrulama alt boyutlarında ise herhangi bir kazanımın olmadığı belirlenmiştir.

Altıncı sınıf düzeyindeki kazanımlar incelendiğinde, toplam 71 kazanımın olduğu belirlenmiştir. Bu kazanımların en fazla %53,5 oranıyla uygulama alanında yer aldığı görülmektedir. Uygulamadan sonra akıl yürütme alanı %30,9 oranında bulunmuştur. En az kazanımın bilme alanında yer aldığı belirlenmiştir (% 15,4). Kazanımlar alt boyutlara dağılımları açısından değerlendirildiğinde ise genel görünüme benzer şekilde uygulama bilişsel alanının uygulama alt boyutu %38'lik temsil oranıyla programda en çok temsil edilen kazanım olmuştur. Bunu akıl yürütme alanından analiz alt boyutu (%18,3) takip etmiştir. İlgili sınıf düzeyinde sunma-modelleme ve sentez %8,4 oranında; tanıma ve karar verme %7 oranında temsil edilmiştir. Ayrıca hatırlama, sıralama-sınıflama, hesaplama, ölçme ve sonuç çıkarma alt boyutlarıyla ilişkili olan kazanım sayısının oldukça az olduğu görülmüştür. Beşinci sınıf düzeyine benzer olarak bilgi alma, genelleme ve doğrulamada hiçbir kazanımın olmadığı belirlenmiştir. Ayrıca 5. sınıfta bir kazanımla temsil edilen değerlendirme alt boyutunda 6. Sınıf düzeyinde hiçbir kazanım bulunmamaktadır.

7. sınıfta 63 tane kazanım bulunmaktadır. Bu kazanımlar daha çok uygulama (%60,3) alanıyla örtüşmüştür. Akıl yürütme %23,8, bilme alanı ise kazanımların %15,8'ini oluşturmuştur. Alt boyutlara bakıldığında genel tabloya benzer şekilde uygulama (%36,5) alt boyutu en çok kazanımın bulunduğu alt boyuttur. Akıl yürütme alanında en çok analiz (%12,6) kazanımlarının bulunduğu görülmektedir. Bilme alanında ise en çok hesaplama (%9,5) alt boyutuna yer verilmiştir. Hatırlama, tanıma, sıralama-sınıflama, sentez, sonuç çıkarma, genelleme gibi alt boyutlarda çok az kazanım bulunduğu belirlenmiştir. Bilgi alma, ölçme, değerlendirme ve doğrulama alt boyutlarında hiçbir kazanımın olmadığı görülmektedir.

8.sınıf kazanımları incelendiğinde değerlendirmeye alınan toplam 61 kazanım bulunmaktadır. Kazanımların dağılımında dikkat çeken uygulama bilişsel alanının kazanımların yaklaşık olarak yarısını oluşturmasıdır. En az kazanım bilme basamağındadır. Akıl yürütme basamağı ise %34 oranında dağılım göstermiştir. Alt boyutların tamamına bakıldığında analiz, sunma-modelleme, uygulama ve tanıma alt boyutları öne çıkmaktadır. Buna karşın hatırlama, sıralama-sınıflama, bilgi alma, ölçme, genelleme ve doğrulama alt boyutlarında hiçbir kazanımın olmadığı belirlenmiştir.

Her bir öğrenme alanındaki kazanımların bilişsel düzeylerine bakıldığında sayılar öğrenme alanındaki 116 kazanımın %39'unun bilme, %50'sinin uygulama ve %11'inin akıl yürütme düzeyinde olduğu görülmektedir. Alt boyutlarda ise sayılar öğrenme alanındaki kazanımların yarısının uygulama bilişsel alanının uygulama alt boyutu ile ilişkilendirildiği belirlenmiştir. Bilme bilişsel alanında hesaplama ve tanıma alt boyutlarının kazanımlarının büyük bölümünü oluşturduğu görülmektedir. Buna karşın bilgi alma ve ölçme alt boyutlarıyla hiçbir kazanım ilişkilendirilmemiştir. Uygulama bilişsel alanında uygulama alt boyutunun ve karar verme alt boyutlarının ön plana çıktığı söylenebilir. Akıl yürütme bilişsel alanında analiz alt boyutunun ağırlıkta olduğu görülmektedir. Sentez ve değerlendirmeye çok az yer verilirken sonuç çıkarma, genelleme ve doğrulama alt boyutlarında ise hiçbir kazanım bulunmamaktadır.

Cebir öğrenme alanında en fazla uygulama en az bilme bilişsel alanına yer verildiği görülmektedir. Bilme bilişsel alanında tanıma ve hesaplamaya çok az yer verilirken sınıflama, bilgi alma ve ölçmede hiçbir kazanım bulunmamaktadır. Uygulama bilişsel alanında sunma-modelleme ve uygulama alt boyutlarının ağırlıkta olduğu görülmektedir. Karar verme alt boyutuna ise çok az yer verilmiştir. Akıl yürütme bilişsel alanında ise analiz alt boyutu kazanımların çoğunluğunu oluşturmasıyla göze çarpmaktadır. Sentez ve genellemeye çok az yer verilirken değerlendirme, sonuç çıkarma ve doğrulama alt boyutlarında hiçbir kazanım bulunmamaktadır.

Geometri ve ölçme öğrenme alanındaki 107 kazanımın %25,2'si bilme, %43,9'u uygulama ve %30,8'i akıl yürütme düzeyindedir. Alt boyutlar açısından bazı farklılıklar göze çarpmaktadır. Diğer öğrenme alanlarına göre daha homojen bir yapıda olan bu dağılıma göre bilme bilişsel alanında tanıma (%12,1), uygulama bilişsel alanında uygulama (%18,6) ve akıl yürütme bilişsel alanında da analiz (%16,8) alt boyutları ön plana çıkmaktadır. Bilme bilişsel alanında bilgi alma alt boyutu, akıl yürütme bilişsel alanında değerlendirme, genelleme ve doğrulama alt boyutlarında kazanıma rastlanmamıştır.

Veri işleme öğrenme alanındaki kazanımların dağılımının diğer öğrenme alanlarına göre farklılıklar gösterdiği söylenebilir. Bilme bilişsel alanında hiçbir kazanımın olmaması dikkat çekicidir. Kazanımlar homojen bir dağılım göstererek uygulama ve akıl yürütme bilişsel alanları kazanımların yarısını oluşturacak şekilde yer almaktadır. Uygulamada sunma-modelleme ve uygulama alt boyutu ön plana çıkarken akıl yürütme bilişsel alanında analiz alt boyutu ön plandadır. Akıl yürütme bilişsel alanında tıpkı geometri öğrenme alanında olduğu gibi genelleme ve doğrulama alt boyutlarında kazanıma rastlanmamıştır.

Olasılık öğrenme alanında bulunan kazanımların bilişsel düzeylerinin dağılımı veri işleme öğrenme alanındakine benzer bir nitelik taşımaktadır. Genel olarak en az kazanımın bulunduğu bu öğrenme alanında bilme bilişsel alanında hiçbir kazanımın olmadığı görülmüştür. Uygulama bilişsel alanında sunma-modelleme alt boyutunda kazanımın olmadığı belirlenmiştir. Akıl yürütme bilişsel alanında ise sentez ve sonuç çıkarma alt boyutlarından birer tane kazanım olduğu görülmüştür. Analiz, değerlendirme, genelleme ve doğrulama alt boyutlarında ise hiçbir kazanım yoktur.

Tartışma ve Sonuç

Sınıf düzeyi açısından değerlendirildiğinde, beşinci sınıfta bilme – uygulama – akıl yürütmeye yönelik kazanımların sırasıyla %58,9-%32,8-%8,2 olduğu tespit edilmiştir. Bu çalışmadan elde edilen sonuca bakıldığında, 5. sınıf için de ilkokul müfredatında olduğu gibi bilme düzeyindeki kazanımların ağırlıkta olduğu söylenebilir.

Altıncı sınıftaki kazanımlar incelendiğinde, bilme düzeyindeki kazanımların %15,4 uygulama düzeyinin %53,5 ve akıl yürütme düzeyinin %30,9 oranında olduğu görülmektedir. İlkokul yıllarından bu yana bilme düzeyi ağırlıklı kazanımların, altıncı sınıfta çok keskin bir geçişle çoğunluğunun uygulama basamağında yer aldığı görülmektedir.

Yedinci sınıfta ise, kazanımların %60'lık kısmını uygulama basamağının oluşturduğu tespit edilmiştir. Akıl yürütme %23,8, bilme alanı ise kazanımların %15,8'ini oluşturmuştur. Yedinci sınıf kazanımları incelendiğinde, öğrencilerin öğrendikleri matematiksel konu ve kavramlara yönelik problemler çözmesinin hedeflendiği görülmektedir. Bu bağlamda uygulama basamağının ağırlıkta olması olağan bir durumdur. 8. sınıftaki kazanımlarda ise, uygulama ve akıl yürütme basamaklarındaki kazanımların benzer oranda, bilme düzeyinin yalnızca %10'luk bir dilimde kaldığı tespit edilmiştir. 2013 ve 2009 öğretim programlarının incelendiği çalışmalara bakıldığında, bilme düzeyine yönelik kazanımların hem 7. sınıfta hem de 8. sınıfta daha yüksek olduğu görülmektedir (İncikabı vd., 2016; Kılıç, Tutak & Aktaş, 2014). Bu doğrultuda, 2019 TIMSS raporuna bakıldığında, Türkiye'nin önceki yıllara göre daha yüksek skora ulaştığı, özellikle matematik dersinde akıl yürütme sorularına yönelik başarının arttığı bilinmektedir (TIMSS, 2019). Bu sonuç, kazanımların akıl yürütme düzeyine kaydırılmasının olumlu sonuçlarından biri olabilir.

Bir diğer yandan, uygulama ve akıl yürütme düzeyindeki kazanımları tamamlamış, 8. sınıfı bitiren öğrencilerin, öğrendikleri matematik konularına yönelik rutin ve rutin olmayan problemleri rahatlıkla çözebiliyor olmalarını beklenir. Bu doğrultuda, MEB'in 2022 yılında yayımladığı Ortaöğretim Kurumlarına İlişkin Merkezi Sınav Raporu (MEB, 2022) incelendiğinde, 2022 yılında LGS'ye giren öğrencilerin 20 soruluk matematik testindeki doğru cevap ortalamalarının 4,74 olduğu görülmektedir. LGS'ye 8. sınıftaki öğrencilerin yaklaşık %85'inin katıldığı düşünüldüğünde (MEB, 2022), LGS 'nin öğrencilerin tamamının genel durumu hakkında TIMSS'e göre daha doğru sonuçlar verdiği söylenebilir. Ayrıca 2019 ve 2020 yılları LGS sonuçlarının da benzer olduğu bilinmektedir (MEB,2022). Bu durumda, programdaki kazanımların sınıf ortamına nasıl yansıdığı sorusu akla gelmektedir. Örneğin bu kazanımlar doğrultusunda hazırlanan ders kitaplarındaki soruların bilişsel düzeye göre analizini bildiren çalışmalar, soruların büyük çoğunluğunun bilme- uygulama düzeyi ağırlıklı olduğunu, akıl yürütme düzeyindeki soru sayısının yeterli olmadığını bildirmektedir (Tutak & Farımaz, 2022; Taşpınar Şener ve Bulut, 2022; Yılmaz, Ay &Aydın, 2021). Örneğin Yılmaz, Ay ve Aydın (2021) veri işleme alanına yönelik ders kitaplarındaki soruların uygulama bilişsel alanına yönelik olduğunu, fakat kazanımların akıl yürütme düzeyi ağırlıklı olduğunu bildirmişlerdir. Yakar (2020), Ortaokul 5. sınıf Matematik Ders Kitabını, öğretim programı kazanımlarını ve kazanımların açıklamalarını karşılama durumunu incelemiştir. Buna göre, ders kitabında program kazanım veya kazanım açıklamalarından bazılarına hiç yer verilmediği, bazılarının ise gerektiği gibi ele alınmadığı tespit edilmiştir. Taşpınar Şener ve Bulut (2022) yaptıkları çalışmada, 8. sınıf matematik ders kitabında akıl yürütme düzeyindeki soru sayısının yetersiz olduğunu, ders kitaplarının, öğretim programındaki kazanımlar dikkate alınarak oluşturulduğu bilindiğine göre, kazanımların da revize edilmesi gerektiğini bildirmişlerdir. Fakat bu çalışmada, 8. sınıf akıl yürütme düzeyindeki kazanımların zaten yüksek oranda olduğu ortaya çıkmıştır. Taşpınar Şener ve Bulut (2022) çalışmalarında, ders kitabının üniteleri sunma biçiminin öğrencilerin kendi kendilerine yorumlayıp sonuç çıkarabileceği şekilde düzenlenmediğini, her adımın kitapta verilerek 'gösterip yaptırma' tekniğinin benimsendiğini bildirmişlerdir. Bu durumda, kazanımlar akıl yürütme düzeyinde olsa bile, kitaplara yansıması farklı olmuş olabilir. Dolayısıyla ders kitaplarının, kazanımları ele alma biçimi önem kazanmaktadır. Buradan hareketle özellikle analiz düzeyindeki kazanımların ders

kitabında nasıl ele alındığını bildiren çalışmalara ihtiyaç olduğu düşünülmektedir. Güzel, Bozkurt ve Özmantar (2020), ders kitaplarındaki etkinliklerin amaçlarının öğretmenler tarafından farklı algılandığını ve farklı bilişsel seviyelerin ortaya çıktığını bildirmişlerdir. Dolayısıyla, öğretmenlerin de müfredattaki kazanımları nasıl algıladıkları ve sınıf ortamına nasıl yansıttıkları önemli bir konudur.

Bilme, uygulama ve akıl yürütme düzeylerinin alt boyutlarına bakıldığında, bilme alanı içerisinde en fazla kazanımın hesaplama ve tanıma düzeyinde çıktığı tespit edilmiştir. Uygulama ve akıl yürütme düzeylerine ulaşmak için, öğrencilerin matematiksel işlem prosedürlerini tanımaları ve akıcı bir şekilde hesap yapıyor olmaları gerekmektedir. Tüm problem türlerini çözmek için belli temel hesaplamaları yapabilmek önemlidir (Mullis & Martin, 2017). Bu bağlamda, tanıma ve hesaplama düzeyindeki kazanımların yüksek oranda olması doğal bir durumdur. Nitekim 2013 yılı öğretim programında da benzer bir sonuçla karşılaşılmıştır (İncikabı vd., 2017). Uygulama alanı içerisinde ise en fazla kazanımın uygulama basamağında, daha sonra ise sunma-modelleme basamağında yer aldığı tespit edilmiştir. Genel olarak uygulama basamağındaki kazanımlara bakıldığında, mevcut bilgileri kullanarak problem çözmeyi gerektiren kazanımlar olduğu görülmüştür. TIMSS sınavlarında da kullanılan problemler, gerçek yaşam durumları içerisinden olduğu gibi, cebirsel ifadeler, fonksiyonlar, denklemler, geometri veya istatistik alanlarına yönelik tüm matematik konularından olabilmektedir (Mullis & Martin, 2017). Bu çalışmada da, tüm öğrenme alanlarına yönelik (sayılar ve işlemler, cebir, geometri ve ölçme, veri işleme, olasılık) uygulama basağında kazanımların olduğu görülmektedir. Bu durum TIMSS uygulamalarıyla paralellik göstermektedir. Akıl yürütme alanı içerisinde, kazanımların analiz düzeyinde yoğunlaştığı görülmektedir. İncelenen tüm sınıflara ait analiz düzeyinde kazanımlara rastlanmış olsa da, en yüksek oran 8. sınıfta çıkmıştır. Öğrencilerin bilişsel seviyeleri arttıkça üst düzey kazanımlarla karşılaşmaları gerekmektedir. Aynı zamanda, öğrencilerin öğrendikleri matematiksel bilgileri ilişkilendirmeleri bakımından bu düzeyin yüksek oranda çıkması istenen bir durumdur. Sentez düzeyindeki kazanımlara da 6, 7. ve 8. sınıflarda rastlanmıştır. Akıl yürütme alanındaki diğer kazanımlar ise son derece az sayıdadır. Doğan (2020) İlkokul Matematik Öğretim Programındaki kazanımların solo sınıflandırmasına göre incelediği çalışmasında benzer şekilde öğrencilerin ulaşması hedeflenen kazanımlarda daha üst düzey zihinsel beceri basamaklarına hitap eden kazanımlara yer verilmesi gerektiği belirtmiştir. Özellikle değerlendirme ve genelleme düzeyindeki kazanımlara ihtiyaç duyulduğu düşünülmektedir. Nitekim yapılan çalışmalara bakıldığında, öğrencilerin kendi problem çözümlerinde bile uygun değerlendirmelerde bulunamadıkları ortaya konmuştur (Deringöl, 2006; Gökkurt, Örnek, Hayat & Soylu, 2015). Ayrıca, aritmetikten cebire geçiş sürecinde ve hatta cebir öncesi dönemde öğrencilerin kazanması gereken önemli becerilerden birinin de genelleme yapmadır (Baki, 2008; Kaput, 1998). Fakat öğrencilerin problem çözümlerini genelleme sürecinde zorlandıkları da bilinmektedir (Baştürk, 2021). Bu bağlamda, akıl yürütme alanına yönelik diğer düzeylere ait kazanımların ortaokul düzeyinde yer alması önemlidir.

Öneriler

Bu çalışma ortaokul programının, TIMSS'e göre bilme ve akıl yürütme bilişsel alanına daha az, uygulama bilişsel alanına daha fazla yer verdiğini ortaya koymuştur. Bu doğrultuda programın bilişsel alanları daha dengeli biçimde içerecek şekilde revize edilmesinin faydalı olacağı düşünülmektedir. Ayrıca elde edilen bulgular kazanımların sınıf ortamına ne düzeyde yansıtıldığı sorusunu akla getirmiştir. Bu bağlamda, özellikle akıl yürütme düzeyindeki kazanımların ders kitaplarında nasıl ele alındığını ortaya çıkaracak çalışmalar yapılabilir. Ayrıca kazanımlar doğrultusunda öğretmenlerin

hazırladığı problemler, materyaller incelenerek öğretmenlerin bu kazanımları ne düzeyde sınıf ortamına yansıttığı incelenebilir.