Bartın University
Journal of Faculty of Education

dergipark.org.tr/buefad
2024, Volume 13, Issue 1, 63-83
DOI: 10.14686/buefad.1133056

Analysis of Middle School Mathematics and Science Curriculum Learning Outcomes According to TIMSS-2019 Evaluation Frameworks

Gökçe OK [a*], *Deniz KAYA* [b]

a Assoc. Prof. Dr., Ministry of Interior, https://orcid.org/0000-0002-2753-178X * bilgi@gokceok.org
b Assoc. Prof. Dr., Nevşehir Hacı Bektaş Veli University, https://orcid.org/0000-0002-7804-1772

Research Article
Received: 20.6.2022
Revised: 17.8.2022
Accepted: 7.9.2022

Abstract

The purpose of this research is to examine the cognitive qualities of the learning outcomes in middle school mathematics and science curricula according to grade levels and learning fields. In the study, case design, one of the qualitative research methods, was used and the data were collected with the help of document analysis technique. The learning outcomes in the middle school mathematics and science curricula published by the Ministry of National Education Board of Education and Discipline in 2018 were discussed on the axis of cognitive domains and sub-dimensions in the TIMSS-2019 evaluation frameworks. Descriptive analysis technique was used to examine the learning outcomes in the curricula. In this context, 215 outcome expressions in the mathematics curriculum and 223 learning outcome expressions in the science curriculum were evaluated. According to the findings of the study, while 46.6% of the learning outcomes in the mathematics curriculum are in the domain of knowing, 36.6% of them are in the applying, 16.8% of them are in the reasoning cognitive domain; 27.1% of the learning outcomes in the science curriculum are in the knowing, 32.4% of them are in the applying and 40.5% of them are in the reasoning cognitive domain. According to the findings, it was suggested that learning outcomes should be updated to include more metacognitive skills, and that primary and secondary teaching programs should be evaluated according to similar frameworks.

Keywords: Cognitive domain, learning outcomes, mathematics, science, TIMSS.

Ortaokul Matematik ve Fen Bilimleri Öğretim Programları Kazanımlarının TIMSS-2019 Değerlendirme Çerçevelerine Göre Analizi

Öz

Bu araştırmanın amacı, ortaokul matematik ve fen bilimleri dersi öğretim programlarındaki kazanımların bilişsel niteliklerini sınıf düzeylerine ve öğrenme alanlarına göre incelemektir. Çalışmada, nitel araştırma yöntemlerinden durum deseni kullanılmış ve veriler doküman incelemesi tekniği yardımıyla toplanmıştır. 2018 yılında Milli Eğitim Bakanlığı Talim Terbiye Kurulu Başkanlığı tarafından yayımlanan ortaokul matematik ile fen bilimleri dersi öğretim programlarındaki kazanımlar TIMSS-2019 değerlendirme çerçevelerindeki bilişsel alanlar ile alt boyutları ekseninde ele alınmıştır. Öğretim programlarındaki kazanımların incelenmesinde betimsel analiz tekniği kullanılmıştır. Bu bağlamda, matematik öğretim programında 215, fen bilimleri öğretim programında 223 kazanım ifadesi değerlendirilmiştir. Çalışmanın bulgularına göre, matematik öğretim programındaki kazanımların %46,6'sı bilme, %36,6'sı uygulama, %16,8'i akıl yürütme bilişsel alanında yer alırken fen bilimleri öğretim programındaki kazanımların %27,1'i bilme, %32,4'ü uygulama ve %40,5'i akıl yürütme bilişsel alanında bulunmaktadır. Çalışma bulgularına göre, kazanımların daha fazla üst bilişsel becerileri içerecek şekilde güncellenmesi ve ilkokul ile ortaöğretim öğretim programlarının da benzer çerçevelere göre değerlendirilmesi öneri olarak sunulmuştur.

Anahtar kelimeler: Bilişsel alanlar, kazanım, matematik, fen bilimleri, TIMSS.

To cite this article in APA Style:

Ok, G., & Kaya, D. (2024). Analysis of middle school mathematics and science curriculum learning outcomes according to TIMSS-2019 evaluation frameworks. *Bartın University Journal of Faculty of Education, 13*(1), 63-83. https://doi.org/10.14686/buefad.1133056

INTRODUCTION

With the rapid changes experienced in the information age, the importance of individual differences is increasing day by day and individual differences are more prominent in educational systems. The inevitable rise of knowledge and information, especially due to technological advances, has led to radical changes in the roles of individuals. Therefore, curricula that put individuals in the center have entered the race to evolve towards an innovative understanding rather than their current deficiencies (TEDMEM, 2022). This mentality has necessitated a change in the systems that guide education policies and has caused radical changes in the dynamics of the curricula of many nations (Common Core State Standards Initiative [CCSSI], 2010; Ministry of National Education [MoNE], 2017; National Council of Teachers of Mathematics [NCTM], 2014; National Research Council [NRC], 2011). Although these changes were not effective in solving the problems completely, they constituted an important step in the development of the concept of Society 5.0 (super smart society) (Holroyd, 2022; Saracel & Aksoy, 2020). Influenced by these changes, our country's education system has aimed to raise individuals who can produce, solve problems, think critically, contribute to the society, have entrepreneurial and communication skills. In this context, it has made an effort to create a curriculum that is more integrated with skills, competence, daily life, and other disciplines by carrying out structural reforms in the curriculum (MoNE, 2018a, 2018b). In this direction, existing curricula, especially science and mathematics curricula have been renewed to meet both the requirements of the era and the changing needs of individuals and society (MoNE, 2017). This situation has become an essential transformation not only in the educational system of our country, but also in the educational system of many countries, and the importance of curricula responding to the differing needs of individuals has often been emphasized (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021). In today's technology-centered societies, especially in the 2000s, as a result of the rapid change in digital technology, differentiation of education from the direction of information transfer to the direction of skill development has made it necessary to update the content of current curricula (Feriver & Arık, 2021).

Renewal, development, and updating of curricula in Turkey were completed in the 2015-2016 academic year. However, comprehensive renewal (update, revision, and change) works have been continued from the beginning of the 2016-2017 academic year to the present day, by considering a different dimension of them (MoNE, 2017). The starting point of structural changes is to enable our children, who will be the guarantee of the future, to grow up more equipped and to meet the needs of individuals and society on the axis of innovative developments in learning-teaching approaches (MoNE, 2017). With this belief, the curricula determined by the MoNE aim to provide individuals with knowledge, skills, and behaviors integrated with values and competencies (MoNE, 2018a, 2018b). The skills that individuals will need are determined in the Turkish Competencies Framework (TCF) in the form of communication in mother tongue and foreign languages, and mathematical, basic, science/technology, digital, learning, social and civic, initiative and entrepreneurship competencies (MoNE, 2018a, 2018b). According to this purpose, among the main objectives of the curriculum implemented are favorable changes in the students' behavior or the behaviors planned to be acquired by the students (Tekin, 2009). On the other hand, curricula consist of learning outcomes, contents, learning-teaching processes and measurement-evaluation items. With this feature, curricula are very important programs for schools (Hewitt, 2018). Therefore, the level of attainment of the learning outcomes in the curriculum is a guide for the learning-teaching process to serve a certain purpose (Birgin, 2016). In accordance with the purpose of the Turkish Ministry of National Education's curricula, "on the one hand, repetitive learning outcomes and explanations at the different subject and grade levels with a spiral approach, on the other hand, learning outcomes that are aimed to be acquired holistically and at once are included" (MoNE, 2018a, p. 4). Therefore, an effort has been made to act with a mentality that puts individuals in the center while preparing the curricula. While the mathematics curriculum, which was renewed at the middle school level consists of learning fields which are numbers and operations, algebra, geometry and measurement, data processing, and probability, the science curriculum consists of learning fields which are the earth-universe, living-life, physical events, matter-nature (MoNE, 2018a, 2018b).

Theoretical Frameworks

Trends in International Mathematics and Science Study (TIMSS) is a four-year success monitoring study conducted by the International Association for the Evaluation of Educational Achievement (IEA). According to the data in 2019, 39 countries participated in the monitoring study, which measured the mathematics and science performance of eighth-grade students (MoNE, 2020). TIMSS, which made its first implementation in 1995, aims to obtain data on how education systems around the world carry out and improve mathematics and science learning. Since TIMSS data provides the opportunity to compare the achievements of the students of the participating countries, it is very useful in the development improvement of the curriculum and also in obtaining information about the general situation of the education strategies of the countries (Hooper et al., 2013). On the other hand, since TIMSS is the most comprehensive student achievement assessment study in the world, it also contributes significantly to the effectiveness and efficiency of education systems (Cotter et al., 2020). In particular, the fact that countries enable them to conduct studies both on their own education systems and comparatively with other countries increases the importance of TIMSS data even more. The increase in the necessity and importance of international assessment exams with each passing day also positively affects the interest and participation of countries in these exams. Therefore, it guides and gives ideas to the participating countries not only about student achievements but also about schools, teachers, families and education systems (Mullis et al., 2016). In this respect, it provides information about the strengths and weaknesses of the education system to experts who prepare curricula, curricula politicians, and researchers. It also provides an important data set to researchers as it includes various variables that affect the mathematics and science achievements of participating country students (Foy, 2017; Martin et al., 2016). In this data set, in addition to the achievement scores of the students of the participating countries, there is also information obtained from their teachers, parents and administrators through questionnaires on the variables that affect student success (MoNE, 2020). The data obtained are analyzed and interpreted in line with certain evaluation frameworks. TIMSS not only provides information about the rankings and student scores of the participating countries, but also shares information that is quite comprehensive and allows comparison.

The mathematics and science TIMMS-2019 evaluation frameworks used within the scope of the study are based on the evaluation history of TIMSS for 24 years. Evaluation frameworks used in monitoring research conducted once in every four years are updated on specific issues in order to have better standards. The distribution of the TIMSS-2019 mathematics evaluation framework according to the cognitive domains in the eighth-grade consists of 35% knowing, 40% applying and 25% reasoning. In the domain of knowing within the framework of mathematics evaluation, students are mostly expected to establish relationships between basic knowledge in order to solve problems. In order to use mathematical methods fluently, students are required to remember a series of actions and how to perform them, and to be able to use various calculation methods and tools correctly (Lindquist et al., 2017). Subject fields that constitute the cognitive domain of knowing consist of the dimensions of recalling, recognizing, classifying/ordering, computing, retrieving and measuring. In the domain of application, problems can be presented both in real-life situations and can be related to mathematical subjects such as algebraic expressions, functions, equations, geometric shapes or statistical datasets (Mullis, 2017). The subject fields that constitute the cognitive domain of application include determining, representing modeling and implementing. The reasoning domain includes logical and systematic thinking. It also covers the determination and correct implementation of methods that can be used to solve problems in new and non-routine situations. Therefore, students are expected to use multiple skills together when solving questions in the domain of reasoning (Foy, 2017; Mullis, 2017). The subject fields that constitute the cognitive domain of reasoning consist of the dimensions of analyzing, synthesizing, evaluating, drawing conclusions, generalizing, and justifying.

On the other hand, the distribution of the TIMSS-2019 science evaluation framework by cognitive domains at the eighth-grade level is 35% knowing, 35% applying, and 30% reasoning. The domain of knowing within the science evaluation framework is the step in which students' knowledge about facts, relationships, processes, concepts and tools is evaluated. The basic knowledge in this field enables students to succeed in more complex processes required for scientific research (Centurino & Jones, 2017; Foy, 2017). The subject fields of the cognitive domain of knowing are the fields of recalling-recognizing, describing and providing examples. In the domain of application students are expected to apply their knowledge of facts, relationships, processes, concepts, and methods to problematic situations (Centurino & Jones, 2017). The subject fields that constitute the cognitive domain of application are comparing, classifying, relating, using models, interpreting information and explaining. In the domain of reasoning, students are required to reason in order to analyze the information presented, draw conclusions and adapt what they know to new situations. As in the domain of applying, questions in the domain of reasoning rather than direct application of knowledge and skills involve new and more complex situations. Reasoning also includes hypothesizing and designing scientific research (Centurino & Jones, 2017; Mullis et al., 2020). The subject fields that constitute the cognitive domain of reasoning are analyzing, synthesizing, formulating questions-hypothesizing-predicting, designing investigations, evaluating, drawing conclusions, generalizing, and justifying.

When the literature is examined, it can be seen that the middle school mathematics curriculum is discussed within the scope of TIMSS-2015 exam (Baysura, 2017; Erdoğan, 2020), the science curriculum is discussed within the scope of TIMSS-2015 (Böyük, 2017; Pedük, 2019), science questions in the central exams is discussed in the context of TIMSS-2019 cognitive domains (Bostan-Sarıoğlan et al., 2021), TIMSS-2015 mathematics success is discussed with the help of the cognitive diagnostic model (Parlak, 2017), learning outcomes in data processing learning field is discussed in the context of TIMSS-2019 cognitive domains (Yılmaz et al., 2021), elementary school mathematics curriculum learning outcomes is discussed on the axis of TIMSS-2019 evaluation framework (Delil et al., 2020), science curriculum is discussed within the scope of the impact of the TIMSS-2007 and TIMSS-2011 monitoring exams (Yatağan, 2014), mathematics curriculum is discussed in line with the changes in TIMSS-2011 perspective (Kılıç et al., 2014), questions in the mathematics workbook is discussed in the context of the TIMSS-2019 exam (Sümen, 2021) and mathematics curriculum learning outcomes is discussed within the scope of the cognitive domains within the TIMSS-2015 mathematics framework. In most of the researches, TIMSS cognitive domain levels in the past years were discussed. For example, the learning outcomes in the science curriculum were examined by Pedük (2019) within the scope of TIMSS-2015 cognitive domain levels. At the end of the study, it was reported that in the science curriculum, the learning outcomes at the level of knowledge were mostly in the field of living things and life, the learning outcomes at the level of applying were mostly in the field of the physical events and the learning outcomes at the level of reasoning were mostly again in the field of living things and life. On the other hand, it was concluded that the learning outcomes at the knowing level were mostly in the seventh-grade, the learning outcomes at the applying level were mostly in the fifth-grade, and the learning outcomes at the reasoning level were mostly in the eighth-grade. In the study conducted by Kılıç et al. (2014), it was stated that the subjects and concepts contained in the articles in the 2013 mathematics curriculum were mostly mentioned in the sixth-grade, and while the items related to applying skills were in the majority in the TIMSS exam, more emphasis was placed on learning outcomes of the ability to know in both the old and new curriculum. The mathematics curriculum was examined by İncikabı et al. (2016) according to TIMSS-2015 cognitive domains. In the study, it was reported that the cognitive domain of knowing was mostly included in the fifth-grade learning outcomes, lower but not much change at other class levels. The applying domain is most commonly included in the seventh-grade curriculum among all classes. While the grade level that included the reasoning domain the most in the curricula was the sixth-grade, the least was the seventh-grade. In the distribution of cognitive characteristics of curriculum learning outcomes by learning fields, it has been reported that the cognitive dimension of knowledge in the fields of numbers and operations, the applying dimension in the fields of algebra, geometry and measurement, and the reasoning dimension in the fields of data processing and probability are intense. On the other hand, it was reported that the learning outcomes related to the dimensions of recalling, determining, generalizing and justifying were not included in any grade level and learning field. In another study conducted by Delil et al. (2020), it was reported that the number of learning outcomes in the primary school mathematics curriculum decreased as one went from the first-grade to the fourth-grade in the knowing level, and the number of learning outcomes increased in the reasoning level. In addition, it was reported that more than half of all the learning outcomes were in the domain of knowing, and the learning outcomes related to the domain of reasoning were included at least.

When the relevant literature is examined in general, the fact that no similar studies have been carried out in the relevant field for both middle school mathematics and science learning fields according to the TIMSS-2019 evaluation framework reveals the necessity of the study. At the same time, considering the fact that TIMSS success monitoring research is carried out at regular intervals, the continuity of such studies in order to determine how the adaptation of the curricula has changed over the years reveals the necessity of the research. In this respect, it is expected that the study will be beneficial both in terms of filling the gap in the relevant field and guiding the curriculum makers. The study, which is considered in accordance with the TIMSS content, is considered valuable in terms of creating a resource and guiding researchers who work or will work in the fields of both mathematics and science curricula. On the other hand, it is hoped that this study will not only provide ideas for similar studies, but also support the development of studies to be done in an original way and making inferences for researchers.

Research Questions

The aim of this research is to examine the learning outcome expressions in the middle school mathematics and science curriculum on the axis of grade levels and learning fields according to the cognitive domain skills in the TIMSS-2019 evaluation frameworks. In accordance with this purpose, answers to the following research questions (RQs) were sought:

RQ 1. What is the distribution of the learning outcome expressions in the middle school mathematics curriculum according to TIMSS-2019 cognitive domain levels?

a) When the middle school mathematics curriculum is examined according to the grade levels, how are the learning outcome expressions at each grade level distributed according to TIMSS-2019 cognitive domain skills?

b) When the middle school mathematics curriculum is examined according to the learning fields, how are the learning outcome expressions in each learning field distributed according to TIMSS-2019 cognitive domain skills?

RQ 2. What is the distribution of the learning outcome expressions in the middle school science curriculum according to TIMSS-2019 cognitive domain levels?

a) When the middle school science curriculum is examined according to grade levels, how are the learning outcome expressions at each grade level distributed according to TIMSS-2019 cognitive domain skills?

b) When the middle school science curriculum is examined according to learning fields, how are the learning outcome expressions in each learning field distributed according to TIMSS-2019 cognitive domain skills?

RQ 3. What is the distribution of total learning outcome expressions in middle school mathematics and science curriculum according to TIMSS-2019 cognitive domain levels?

METHOD

In this research, case design, one of the qualitative research methods was used, and the data obtained were collected with the help of the document analysis technique. Document analysis includes the analysis of written materials containing information about the fact or facts that are aimed to be investigated (Yıldırım & Şimşek, 2018). Documents are important sources of information that should be used effectively in qualitative research, as well as a systematic procedure for the evaluation and review of materials (Yıldırım & Şimşek, 2018). Examination of documents (*i*) accessing documents, (*ii*) checking documents for authenticity, (*iii*) understanding documents, (*iv*) analyzing data, and (*v*) using data (Forster, 1995). In the examination of the documents carried out within the scope of the research, the analysis of written materials containing information about the subjects planned to be researched was used. Descriptive analysis was used while analyzing the document sources in the research. In the descriptive analysis approach, the data obtained are summarized and interpreted according to the previously determined themes (Yıldırım & Şimşek, 2018, p. 239). In this analysis approach, it is stated that it is a frequently used method for researchers to obtain summary information about the different facts and events they want to study (Büyüköztürk et al., 2018). In descriptive analysis, it consists of four stages: (*i*) creating a framework for analysis, (*ii*) processing data according to the thematic framework, (*iii*) defining the obtained findings, and (*iv*) interpreting the findings (Yıldırım & Şimşek, 2018). The data obtained within this process is systematically and clearly described and the general view is tried to be determined. Within the scope of this research, the outcome expressions in the Middle School Mathematics and Science Curricula, implemented by the Ministry of National Education Board of Education and Discipline were examined (MoNE, 2018a, 2018b).

Data Collection

Within the scope of this study, first of all, the Primary School (1-4. Grades) Middle School, and Imam Hatip Middle School (5-8. Grades) Mathematics and Science Curricula, which were adopted by the Ministry of National Education Board of Education and Discipline in 2018, have been saved in PDF formats in a folder created on the computer in order to facilitate the analysis. Afterwards, learning outcomes in the curriculum were transferred to the WORD document as only learning outcome expressions, taking into account the courses and grade levels. 26.1% (56) of the learning outcomes in the mathematics curriculum are at the level of fifth-grade, 27.4% (59) of them are at the level of sixth-grade, 22.3% (48) of them are at the level of seventh-grade, 24.2% (52) of them are at the level of eighth-grade. 49.3% (106) of total outcome expressions are in numbers operations, 10.7% (23) of them are in algebra, 31.1% (67) of them are in geometry and measurement, 6.5% (14) of them are in data processing and 2.3% (5) of them are in probability learning. 16.1% (36) of the learning outcomes in the science curriculum are at the fifth-grade, 26.5% (59) of them are at the sixth-grade, 30.1% (67) of them are at the seventh-grade, and 27.3% (61) of them are at the eighth-grade level. 11.2% (25) of total learning outcome expressions are in the field of learning earth and the universe, 31.8% (71%) of them are in the field of living and life, 33.6% (75) of them are in the field of physical events and 23.4% (52) of them are within the field of matter and nature learning. The table in which the learning outcome expressions in the curricula are expressed in detail according to the grade levels is presented below (Table 1).

Table 1. Number of Learning Outcomes in Mathematics and Science Courses Learning Fields by Grade Levels

Content Domain Related to Courses	Grade Levels				
	5. Grade	6. Grade	7. Grade	8. Grade	Total
	% (f)	% (f)	% (f)	% (f)	% (f)
Mathematics Content Domains					
Numbers and Operations	31.1 (33)	30.2 (32)	23.6 (25)	15.1 (16)	49.3 (106)
Algebra	-	13.1 (3)	30.4 (7)	56.5 (13)	10.7 (23)
Geometry and Measurement	29.8 (20)	28.4 (19)	17.9 (12)	23.9 (16)	31.1 (67)
Data Processing	21.4 (3)	35.7 (5)	28.6 (4)	14.3 (2)	6.5 (14)
Probability	-	-	-	100 (5)	2.3 (5)
Total	26.1 (56)	27.4 (59)	22.3 (48)	24.2 (52)	100 (215)
Science Content Domains					
Earth and Universe	28.0 (7)	20.0 (5)	40.0 (10)	12.0 (3)	11.2 (25)
Living and Life	12.7 (9)	30.9 (22)	21.2 (15)	35.2 (25)	31.8 (71)
Physical Events	18.7 (14)	25.3 (19)	34.7 (26)	21.3 (16)	33.6 (75)
Matter and Nature	11.5 (6)	25.0 (13)	30.8 (16)	32.7 (17)	23.4 (52)
Total	16.1 (36)	26.5 (59)	30.1 (67)	27.3 (61)	100 (223)

In the next step, documents containing TIMSS-2019 mathematics and TIMSS-2019 science evaluation frameworks published by TIMSS & PIRLS international study center were saved in PDF formats. In these documents, there is information for each course in which the cognitive domain and its subdimensions are explained in detail. In this context, in the cognitive domain of knowing for mathematics; there are sub-dimensions of recalling, recognizing, classifying-ordering, computing, retrieving, and measuring. In the cognitive domain of applying; there are sub-dimensions of determining, representing modeling and implementing. In the cognitive domain of reasoning; there are sub-dimensions of analyzing, synthesizing, evaluating, drawing conclusions, generalizing, and justifying. On the other hand, in the cognitive domain of knowing for science; there are sub-dimensions of recalling-recognizing, describing and providing examples. In the cognitive domain of applying; there are sub-dimensions of comparing-classifying, relating, using models, interpreting information and explaining. In the cognitive domain of reasoning there are sub-dimensions of analyzing, synthesizing, formulating questions hypothesizing-predicting, designing investigations, evaluating, drawing conclusions, generalizing, and justifying (Centurino & Jones, 2017; Lindquist et al., 2017). In this context, the tables with detailed explanations of the cognitive domains and sub-dimensions included in the TIMSS-2019 mathematics and science evaluation frameworks published in 2017 are presented below (Table 2 & Table 3).

Table 2. TISS-2019 Mathematics Framework

1. Knowing
1.1. Recall: Recalling descriptions, terminology, number attributes, geometry attributes, and notation (e.g., a *x* b = ab, a + a + a = 3a).
1.2. Recognize: Recognizing mathematical objects, such as shapes, numbers, statements and quantities. Recognizing mathematical concepts that are mathematical equations.
1.3. Classify/Order: Classifying/grouping objects, shapes, numbers and expressions according to their common characteristics; making the right decision about group members and sorting objects and numbers according to their properties.
1.4. Compute: Carrying out algorithmic procedures for +, −, ×, ÷ or their combinations with all numbers, decimals, percentages, and integers. Telling approximate numbers for estimated calculations, performing routine algebraic methods.
1.5. Retrieve: Reading simple scales from charts, tables, or other sources.
1.6. Measure: Using measurement tools, choosing appropriate measurement units.
2. Applying
2.1. Determine: Identifying strategies, tools, and effective and appropriate procedures that are frequently used to solve problems.
2.2. Represent/Model: Showing data in tables or graphs, creating equations, inequalities, geometric figures or diagrams for solving problems, generating equations for given mathematical elements or relationships.
2.3. Implement: Implementing strategies to solve problems involving similar mathematical concepts and operations.
3. Reasoning
3.1. Analyze: Using, explaining or deciding on relationships between objects or variables in mathematical situations and making valid inferences from this information.
3.2. Synthesize: Making connections between different information and related representative elements and related mathematical ideas. Combining mathematical methods, concepts and facts to uncover results and achieve the next result.
3.3. Evaluate: Evaluating different problem-solving strategies and solutions.
3.4. Draw Conclusions: Making inferences based on knowledge and evidence.
3.5. Generalize: Expanding fields where the result of mathematical thinking and problem solving is correct by restating the results in more general and broadly acceptable terms.
3.6. Justify: Supporting solutions and strategies to provide mathematical discussions.

Note: "TIMSS 2019 assessment frameworks". I. V. S. Mullis & M. O. Martin (Eds.), by M. Lindquuist., R. Philpot., I. V. S. Mullis and K. E. Cotter, 2017, pp. 23-24, taken exactly from study (https://timssandpirls.bc.edu/timss2019/frameworks/), Copyright, 2017 by the International Association for the Evaluation of Educational Achievement (IEA).

Table 3. TIMSS-2019 Science Framework

1. Knowing
1.1. Recall/ Recognize: Distinguishes between facts, relationships and concepts. Defines the characteristics of certain living things, materials and processes; defines the use of scientific tools and uses scientific words, scientific notation, abbreviations, units and scales where appropriate.
1.2. Describe: Defines terms related to the tasks, structures and characteristics of living things and materials. It also defines the bonds between facts.
1.3. Provide Examples: Gives examples of living things, matter and tools that have certain qualities. Explains concepts or facts with appropriate examples.
2. Applying
2.1. Compare/Classify: Distinguishes differences and similarities between living things, matter or processes. Distinguishes or groups matter, living things, objects, and processes according to their characteristics.
2.2. Relate: Associates the observed characteristics of objects, living things or tools with science concepts.
2.3. Use Models: Diagrams or different models are used to show the information. With the help of these models, the representation of a process, cycle, relationship and system is made. At the same time, these models help to solve science problems.
2.4. Interpret Information: Uses science concepts when interpreting information in the form of text, pictures, tables or graphics.
2.5. Explain: Can make an observation using any science concept or method, or introduces a phenomenon by explaining or distinguishes it from others.
3. Reasoning
3.1. Analyze: Defines the elements of problems. Uses information, concepts, relationships, and data to solve problems.
3.2. Synthesize: Can answer questions that require multiple concepts to be considered together.
3.3. Formulate Questions/Hypothesize/Predict: Creates a research problem and generates assumptions based on the information provided, while at the same time making assumptions in the light of past experiences, observations and information obtained from different data sources. Uses evidence to make predictions about the effects of changes in biological and physical conditions.
3.4. Design Investigations: Plans appropriate research and methods for seeking answers to scientific questions or checking hypotheses; understands and explains the features of well-designed reviews.
3.5. Evaluate: Evaluates explanation options; decides by comparing the positive and negative aspects of alternative processes and tools. Evaluates whether the data is sufficient on the basis of its results.
3.6. Draw Conclusions: Makes assumptions using observations, evidence and other sources of information. Draws conclusions that address questions or hypotheses and takes into account cause-and-consequence relationships.
3.7. Generalize: Makes inferences about general results beyond data or experimental conditions. Tries the obtained results under new conditions.
3.8. Justify: Uses evidence for scientific suitability of explanations, solutions and review results.

Note: "TIMSS 2019 assessment frameworks". I. V. S. Mullis & M. O. Martin (Eds.), by V. A. S. Centurino and L. R. Jones, 2017, pp. 53-54, taken exactly from study (https://timssandpirls.bc.edu/timss2019/frameworks/), Copyright, 2017 by the International Association for the Evaluation of Educational Achievement (IEA)

Data Analysis

Within the scope of this study, 215 learning outcome expressions were analyzed in the mathematics curriculum and 223 learning outcome expressions were analyzed in the science curriculum. In the analysis of learning outcome expressions, first of all, it was determined according to which criteria the learning outcome expressions in the curricula will be evaluated. Accordingly, it was decided to evaluate the learning outcomes in the curricula according to the grade levels and learning fields. In another step, considering the framework steps in the TIMSS-2019 cognitive domain (knowing, applying, and reasoning), it was determined in which cognitive domains the learning outcome expressions were included. The learning outcome expressions in the curriculum were classified under five learning fields, four class levels and three cognitive domains for each course. In this context, coding in determining the place of learning outcome expression in cognitive domains was made by three researchers. While coding the learning outcome expressions, the course code, grade level, learning field, sub-learning field and learning outcome number were used, respectively (MoNE, 2018a, 2018b). The structure of the learning outcome expressions is shown schematically below (Figure 1).

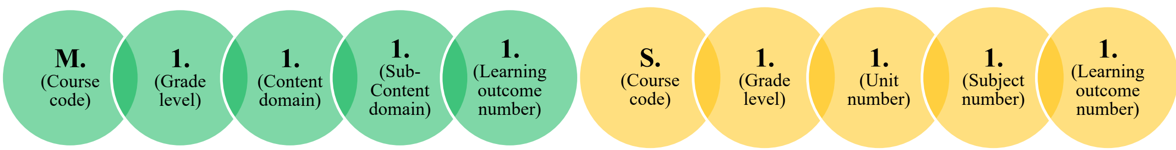

Figure 1. *Schematic Representation of Mathematics and Science Learning Outcomes*

In the other step of the research, codings were made to determine the cognitive domains of the learning outcome expressions in middle school mathematics and science curricula according to the evaluation criteria used. While coding, the code of the learning outcome expressions, the whole of the learning outcome expression, the cognitive domain code and the sub-domain code were written, respectively. For example, in the mathematics curriculum [M.5.1.6.4] "finds the amount corresponding to a specified percentage of a majority" (MoNE, 2018a,

p. 54), the learning outcome expression is coded in the cognitive domain of knowing [1] and in the sub-dimension of computing [1.4]. Similarly, in the Science curriculum [S.5.1.1.1] “explains the characteristics of the sun” (MoNE, 2018b, p. 25), the learning outcome expression is coded in the cognitive domain of knowing [1] and recalling-recognizing [1.1]. However, since some learning outcomes contain more than one verb expression, these learning outcomes are coded under more than one cognitive domain and sub-dimension. For example, in the mathematics curriculum [M.5.1.2.2], “it determines and uses strategy in addition and subtraction from the mind with two-digit natural numbers” (MoNE, 2018a, p. 51) was coded in the cognitive domain of applying of learning outcome [2], determining [2.1] and implement [2.3] dimensions. Similarly, in the science curriculum [S.5.2.1.1], “it classifies according to its similarities and differences by giving examples to living things” (MoNE, 2018b, p. 26) learning outcome is coded in the dimensions of [1] giving examples in the cognitive domain of knowing [1.3] and [2] comparing-classifying in the cognitive domain of applying [2.1]. In this respect, the total number of learning outcomes in the mathematics curriculum containing more than one verb expression was 303 and the total number of learning outcomes in the science curriculum was 247. Thus, a total of 550 learning outcome expressions were included in the analysis of the data. Example codings of learning outcome expressions in mathematics and science curricula are presented below (Table 4).

Table 4. Coding Examples of Some Learning Outcomes in Mathematics and Science Curricula

Outcome Number	Learning Outcome Expression	Cognitive Domain	Sub-Dimension
M.5.1.6.4	Finds the amount that corresponds to a specified percentage of a quantity.	1	1.4
M.6.1.2.4	Determines the prime factors of natural numbers.	2	2.1
M.7.1.4.4	Expresses the relationship between two directly proportional multiplicities.	3	3.1
M.8.2.1.3	Explains identities with models.	2	2.2
S.5.1.1.1	Explains the properties of the sun.	1	1.1
S.6.5.3.1	Compares the speed of sound in different environments.	2	2.1
S.7.4.5.2	Designs a project related to the recycling of domestic solid and liquid waste.	3	3.4
S.8.2.4.1	Explains the adaptation of living things to the environment they live in, by observing.	2	2.5

Validity And Reliability of The Data

In the study, 82 learning outcome expressions at the fifth-grade level, 85 learning outcome expressions at the sixth-grade level, 62 learning outcome expressions at the seventh-grade level, and 74 learning outcome expressions at the eighth-grade level were analyzed in the mathematics curriculum. On the other hand, 38 learning outcomes at the fifth-grade level, 74 at the sixth-grade level, 72 at the seventh-grade level and 63 at the eighth-grade level in the science curriculum were analyzed. In order to ensure the reliability of the data obtained, three experts from the fields of mathematics education, science education, measurement, and evaluation took part in the coding of the learning outcomes. The learning outcome expressions were coded by three independent experts and the formula [Reliability Coefficient=Consensus÷ (Consensus + Disagreement) x100] proposed by Miles and Huberman (1994) was used to determine the percentage of compromise. Accordingly, consensus between the coders was determined as 80% and above for each curriculum. According to coding control that gives the internal consistency of the data, the consensus between the coders is expected to be at least 80% (Miles & Huberman, 1994). In this respect, it can be said that the encoder reliability of the data is ensured. On the other hand, in order to eliminate the differences in the coding of the learning outcome expressions in the curricula, the coders evaluated again and reached a common consensus. In order to ensure the validity of the study, care was taken to explain the procedures performed by the researchers in detail, to define the process correctly, to process and interpret the obtained data correctly. In addition, it was aimed to contribute to the validity of the study by including the detailed contents and access addresses of the documents used in the study (Sandelowski & Barrosa, 2007).

Research Ethics

Since the data of the study is not in the data group that requires ethical committee approval, it does not require ethics committee approval. The article has been prepared in accordance with research and publication ethics.

FINDINGS

In this section, the findings obtained for the purpose of the study are explained in three parts. In the first part, the learning outcome expressions in the middle school mathematics curriculum have been discussed in terms of the cognitive domain and sub-dimensions within the framework of TIMSS-2019 evaluation according to the grade levels. At the same time, the distribution of the learning outcome expressions according to the learning domain in the mathematics program is presented with the help of graphics. In the second part, the learning outcome expressions in the middle school science curriculum are discussed in terms of the cognitive domain and sub-dimensions within the framework of TIMSS2019 evaluation according to the grade levels. At the same time, the distribution of learning outcome expressions according to the learning domain in the science program is shown in the graph. In the last part, the distribution of the learning outcome expressions in the field of mathematics and science curriculum has been presented according to TIMMS-2019 cognitive domain with the help of graph. In addition, the learning outcome expressions in middle school mathematics and science curricula are associated with the cognitive domains determined within the framework of the TIMSS-2019 program according to grade levels and learning domains, and the results are given in frequencies and percentages. In this part of the findings section, the answer to the question of "What is the distribution of the learning outcome expressions in the middle school mathematics curriculum according to the TIMSS-2019 cognitive domain levels?" was sought. In this context, when the middle school mathematics curriculum is examined according to grade levels, the distribution of learning outcome expressions at each grade level in TIMSS-2019 cognitive domain skills is presented below (Table 5).

Table 5. Cognitive Domain Distribution of Learning Outcomes in Mathematics Curriculum by Grade Levels

Cognitive Domain	Sub-Dimensions of Cognitive Domains	Grade Levels			
		5. Grade	6. Grade	7. Grade	8. Grade
		% (f)	*% (f)*	*% (f)*	*% (f)*
1. Knowing	1.1. Recall	9.8 (8)	4.7 (4)	1.6 (1)	2.7 (2)
	1.2. Recognize	8.5 (7)	4.7 (4)	12.9 (8)	10.8 (8)
	1.3. Classify/Order	6.1 (5)	3.5 (3)	1.6 (1)	1.4 (1)
	1.4. Compute	20.7 (17)	23.5 (20)	27.5 (17)	16.2 (12)
	1.5. Retrieve	3.7 (3)	9.4 (8)	1.6 (1)	4.1 (3)
	1.6. Measure	3.7 (3)	5.9 (5)	-	-
2. Applying	2.1. Determine	9.8 (8)	10.6 (9)	11.3 (7)	12.2 (9)
	2.2. Represent/Model	13.4 (11)	3.5 (3)	8.1 (5)	24.4 (18)
	2.3. Implement	10.9 (9)	16.5 (14)	17.7 (11)	9.3 (7)
3. Reasoning	3.1. Analyze	10.9 (9)	10.6 (9)	14.5 (9)	13.5 (10)
	3.2. Synthesize	2.5 (2)	5.9 (5)	3.2 (2)	5.4 (4)
	3.3. Evaluate	-	1.2 (1)	-	-
	3.4. Draw Conclusions	-	-	-	-
	3.5. Generalize	-	-	-	-
	3.6. Justify	-	-	-	-
	Total	100 (82)	100 (85)	100 (62)	100 (74)

When Table 5 is examined, according to the TIMSS cognitive domain evaluation framework, it is seen that a large proportion of the fifth-grade learning outcomes in the mathematics curriculum overlap with the sub-dimensions of cognitive domains of computing (20.7%) in the domain of knowing and represent model (13.4%) in the domain of applying. These sub-dimensions are followed by the sub-dimensions of cognitive domains of implement in the domain of applying (10.9%), analysis in the domain of reasoning (10.9%), and recall in the domain of knowing (9.8%), respectively. Considering the learning outcomes at the sixth-grade level, compute the most in the domain of knowing (23.5%) and implement it in the domain of applying (16.5%) are in the sub-dimensions of cognitive domains. These steps are followed by the sub-dimensions of cognitive domains of determine in the domain of applying (10.6%), analyzing in the domain of reasoning (10.6%) and retrieve in the domain of knowing (9.4). The learning outcomes at the seventh-grade level are more in the sub-dimensions of compute (27.5%) in the domain of knowing and implement (17.7%) in the domain of applying. These sub-dimensions are followed by analysis in the domain of reasoning (14.5%), recognition in the domain of knowing (12.9%) and determine in the domain of applying (11.3%). Finally, when looking at the eighth-grade level learning outcomes, it is seen that present/model (24.4%) in the domain of applying and computing in the domain of knowing (16.2%) are more in the sub-dimensions of cognitive domains. The sub-dimensions of this cognitive domain are followed by analysis in the domain of reasoning (13.59%), determination in the domain of applying (12.2%) and recognition in the domain of knowing (10.8%), respectively. The change in the learning outcomes in the middle school mathematics curriculum in the cognitive domains of TIMSS according to the grade levels is presented below as a percentage (Figure 2).

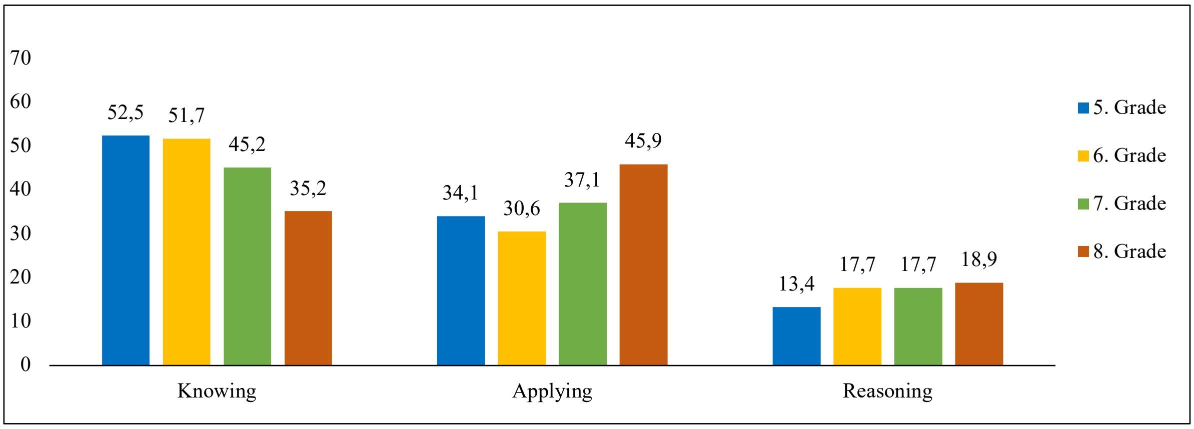

Figure 2. *Changes in the TIMSS Cognitive Domains of the Learning Outcomes in the Mathematics Curriculum*

When Figure 2 is examined, it is seen that there are mostly fifth-grade (52.5%) learning outcomes in the cognitive domain of knowing, but the sixth-grade (51.7%) learning outcomes are also high. The grade level with the least learning outcomes in this cognitive domain was the eighth-grade (35.2%). In the cognitive domain of the applying, there are eighth-grade (45.9%) learning outcomes the most. The grade level with the least learning outcome in this cognitive domain was the sixth-grade (30.6%). While the grade level with the most learning outcomes in the cognitive domain of reasoning was the eighth-grade (18.9%), there were equal learning outcomes in the sixth-and seventh-grade (17.7%) levels. In this context, when the change of TIMSS cognitive domains according to grade levels is examined in general, it is noteworthy that the majority of the learning outcomes in the mathematics curriculum are related to the cognitive domain of knowing. On the other hand, the domain with the least learning outcome among cognitive domains has been the cognitive domain of reasoning. In this part of the study, answers to the question “When the middle school mathematics curriculum is examined according to learning domains, how are the learning outcome expressions in each learning field distributed according to TIMSS-2019 cognitive domain skills?” were sought and the findings obtained are presented in the table below (Table 6).

Table 6. TIMSS Cognitive Domain Distribution of Learning Outcomes in Mathematics Learning Fields

Cognitive Domain	Sub-Dimensions of Cognitive Domains	Content Domain				
		Numbers and Operations	Algebra	Geometry and Measurement	Data Processing	Probability
		% (f)	*% (f)*	*% (f)*	*% (f)*	*% (f)*
1. Knowing	1.1. Recall	7.9 (11)	3.4 (1)	2.8 (3)	-	-
	1.2. Recognize	7.9 (11)	10.3 (3)	11.1 (12)	-	16.7 (1)
	1.3. Classify/Order	6.5 (9)	-	0.9 (1)	-	-
	1.4. Compute	28.8 (40)	24.3 (7)	12.1 (13)	23.8 (5)	16.7 (1)
	1.5. Retrieve	7.2 (10)	10.3 (3)	0.9 (1)	-	16.7 (1)
	1.6. Measure	-	-	7.4 (8)	-	-
2. Applying	2.1. Determine	12.2 (17)	3.4 (1)	12.9 (14)		16.7 (1)
	2.2. Represent/Model	2.9 (4)	20.7 (6)	18.6 (20)	28.6 (6)	16.7 (1)
	2.3. Implement	11.5 (16)	13.8 (4)	17.6 (19)	9.5 (2)	-
3. Reasoning	3.1. Analyze	13.7 (19)	6.9 (2)	8.3 (9)	28.6 (6)	16.7 (1)
	3.2. Synthesize	1.4 (2)	6.9 (2)	6.5 (7)	9.5 (2)	-
	3.3. Evaluate	-	-	0.9 (1)	-	-
	3.4. Draw Conclusions	-	-	-	-	-
	3.5. Generalize	-	-	-	-	-
	3.6. Justify	-	-	-	-	-
	Total	100 (139)	100 (29)	100 (108)	100 (21)	100 (6)

When Table 6 is examined, it is seen that there are more cognitive domain-related learning outcomes in the cognitive sub-dimensions of computing in the domain of knowing (28.8%) and analysis in the domain of reasoning (13.7%) among the learning outcomes in the domain of numbers and operations learning. These sub-dimensions are followed by determining (12.2%) and implementing (11.5%) in the domain of applying, recalling (7.9%), recognizing (7.9%), and retrieving (7.2%) in the domain of knowing. When the learning outcomes in the domain of algebra are examined, there are more learning outcomes in the cognitive sub-dimensions of computing (24.3%) and representing-modeling (20.7%) in the domain of knowing. These cognitive sub-dimensions are followed by the sub-dimensions of implementing in the domain of applying (13.8%) and recognizing in the domain of knowing (10.3%) and retrieving (10.3%) respectively. When the learning outcomes in the field of geometry and measurement are examined, it is seen that the learning outcomes associated with more cognitive domains overlap in the sub-dimensions of representing-modelling (18.6%) in the domain of applying and implementing in the domain of applying (17.6%). These dimensions are followed by the sub-dimensions of determining in the domain of applying (12.9%), computing in the domain of knowing (12.1%) and recognizing (11.1%). When the data processing learning field is examined, there are more learning outcomes in the cognitive sub-dimensions of representing/modeling (28.6%) in the applying domain and analysis (28.6%) in the reasoning domain. These sub-dimensions are followed by the cognitive subdimensions of computing in the domain of knowing (23.8%), performing in the domain of applying (9.5%), and synthesis in the domain of reasoning (9.5%). Finally, learning outcome expressions (16.7%) in the cognitive sub-dimensions of recognizing computing, retrieving, determining and representing-modeling in the domain of learning, and synthesis in the domain of reasoning show equal distribution. The change in learning outcomes in the mathematics curriculum by learning domains is presented below as a percentage (Figure 3).

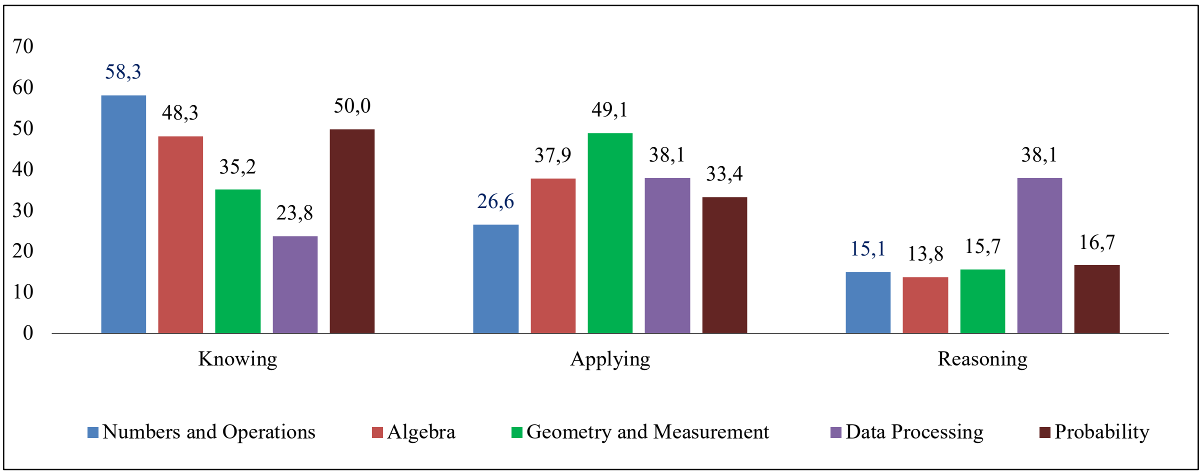

Figure 3. *TIMSS Cognitive Domain Change of Learning Outcomes in Mathematics Learning Fields*

When Figure 3 is examined, it is seen that the majority of the learning outcomes in the field of numbers and operations (58.3%) among the learning outcomes in the middle school mathematics curriculum overlap with the cognitive domain of knowing. Similarly, the learning field of algebra (48.3%) and the learning outcomes within the learning field of probability (50.0%) are largely in the cognitive domain of knowing. On the other hand, one third (35.2%) of the learning outcomes in the field of geometry and measurement and close to one fourth (23.8%) of the learning outcomes in the field of data processing are in the cognitive domain of knowing. The learning field with the highest acquisition rate in the applying cognitive domain is the learning field of geometry and measurement (49.1%), followed by data processing (38.1%) and algebra learning domains (37.9%), respectively. The learning field with the highest acquisition rate in the domain of reasoning is data processing learning (38.1%). The learning ratio of the numbers and operations (15.1%), algebra (13.8%), geometry and measurement (15.7%) and probability (16.7%) in this cognitive domain are also very close to each other. In this part of the study, answers were sought to the question "How are the learning outcome expressions in the middle school science curriculum distributed according to TIMSS-2019 cognitive domain levels?". Accordingly, when the middle school science curriculum is examined according to the grade levels, the distribution of learning outcome expressions at each grade level in TIMSS-2019 cognitive domain skills is presented below.

Table 7. Cognitive Domain Distribution of Learning Outcomes in the Science Curriculum by Grade Levels

Cognitive Domain	Sub-Dimensions of Cognitive Domains	Grade Levels			
		5. Grade	6. Grade	7. Grade	8. Grade
		% (f)	% (f)	% (f)	% (f)
1. Knowing	1.1. Recall/Recognize	21.2 (8)	5.4 (4)	15.3 (11)	7.9 (5)
	1.2. Describe	-	14.9 (11)	4.2 (3)	6.4 (4)
	1.3. Provide Examples	5.2 (2)	8.1 (6)	9.7 (7)	9.5 (6)
2. Applying	2.1. Compare/Classify	5.2 (2)	12.2 (9)	11.1 (8)	4.7 (3)
	2.2. Relate	-	-	1.4 (1)	6.4 (4)
	2.3. Use Models	10.6 (4)	13.5 (10)	5.5 (4)	4.7 (3)
	2.4. Interpret Information	5.2 (2)	-	-	3.2 (2)
	2.5. Explain	15.8 (6)	6.7 (5)	12.5 (9)	12.8 (8)
3. Reasoning	3.1. Analyze	13.2 (5)	9.5 (7)	20.8 (15)	15.9 (10)
	3.2. Synthesize	2.6 (1)	6.7 (5)	8.3 (6)	6.4 (4)
	3.3. Formulate Questions/Hypothesize/Predict	5.2 (2)	10.8 (8)	2.8 (2)	4.7 (3)
	3.4. Design Investigations	2.6 (1)	8.1 (6)	2.8 (2)	4.7 (3)
	3.5. Evaluate	2.6 (1)	2.7 (2)	-	3.2 (2)
	3.6. Draw Conclusions	10.6 (4)	1.4 (1)	5.6 (4)	9.5 (6)
	3.7. Generalize	-	-	-	-
	3.8. Justify	-	-	-	-
	Total	100 (38)	100 (74)	100 (72)	100 (63)

When Table 7 is examined, according to the TIMSS cognitive domain evaluation framework, it is seen that the fifth-grade learning outcomes in the science curriculum are mostly associated with the subdimensions of recalling-recognizing (21.2%) in the domain of knowing and explaining (15.8%) in the domain of applying. These dimensions are followed by analysis in the domain of reasoning (13.2%), using models in the domain of applying (10.6%), and drawing conclusions in the domain of reasoning (10.6%). On the other hand, when the learning outcomes at the sixth-grade level are examined, it is seen that the description (14.9%) in the domain of cognition and the using models in the domain of applying (13.5%) overlap with the sub-dimensions of cognitive domains. These sub-dimensions are followed by comparing-classifying (12.2%) in the domain of applying, formulating questions-hypothesis-prediction (10.8%), and analyzing (9.5%) in the domain of reasoning. When the learning outcomes within the seventh-grade level are examined, it is seen that the most learning outcomes are associated with the subdimensions of cognitive domains analysis in the domain of reasoning (20.8%) and recalling-recognizing in the domain of knowing (15.3%). These sub-dimensions are followed by explaining (12.5%) and comparing-classifying (11.1%) in the domain of applying and giving examples in the domain of knowing (9.7%) in the sub-dimensions of cognitive domains. These sub-dimensions are followed by explaining (12.5%) and comparing-classifying (11.1%) in the domain of applying and giving examples in the domain of knowing (9.7%) in the sub-dimensions of cognitive domains. When the eighth-grade level learning outcomes are examined, it is seen that the sub-dimensions of the cognitive domains are intensive in the domain of analysis (15.9%) and explanation in the domain of applying (12.8%). These sub-dimensions are followed by providing examples in the domain of knowing (9.5%) and drawing conclusions in the domain of reasoning (9.5%). The change in the learning outcomes in the middle school science curriculum in the cognitive domains of TIMSS according to the grade levels is presented below as a percentage (Figure 4).

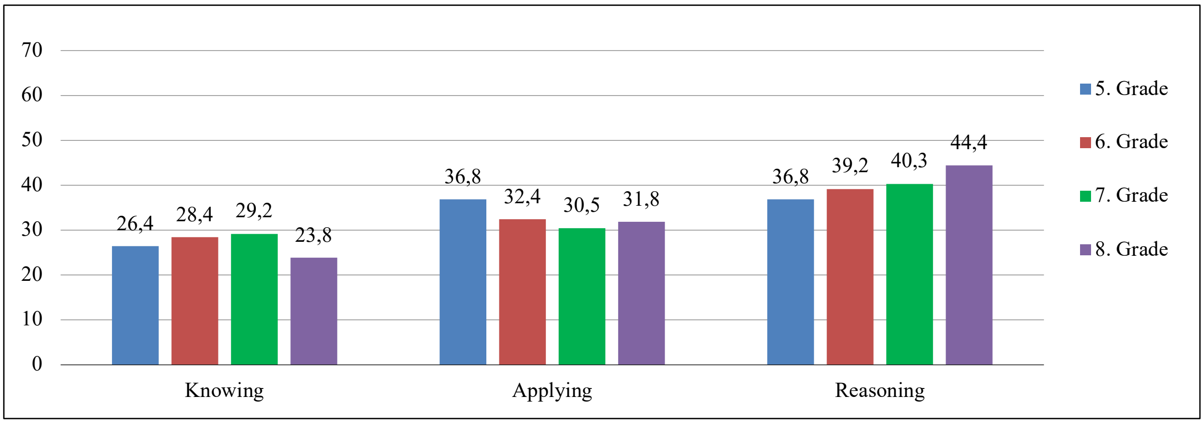

Figure 4. *Changes in TIMSS Cognitive Domains of Learning Outcomes in Science Curriculum*

When Figure 4 is examined, it is seen that there are similar learning outcomes in the cognitive domain of knowing at the levels of fifth-grade (26.4%), sixth-grade (28.4%), seventh-grade (29.2%), and eighth-grade (23.8%). In the cognitive domain of applying, there are fifth-grade (36.8%) level learning outcomes the most, followed by the sixth-grade (32.4%), eighth-grade (31.8%) and seventh-grade (30.5%) levels, respectively. In the cognitive domain of the applying, there are the most fifth-grade (36.8%) level learning outcomes, followed by the sixth-grade (32.4%), eighth-grade (31.8%), and seventh-grade (30.5%) levels, respectively. In the cognitive domain of reasoning, there are the most eighth-grade (44.4%) level learning outcomes, followed by seventh-grade (40.3%), sixth-grade (39.2%) and fifth-grade (36.8%) levels. When the change of TIMSS cognitive domains according to grade levels is examined in general, it is noteworthy that the majority of the learning outcomes in the science curriculum are related to the cognitive domain of reasoning. On the other hand, the domain with the least learning outcome among cognitive domains has been the cognitive domain. In this part of the study, the findings obtained from the question “When the middle school science curriculum is examined according to learning domains, how is the distribution of learning outcomes in each learning field according to TIMSS-2019 cognitive domain skills?” are presented in the table below (Table 8).

Table 8. TIMSS Cognitive Domain Distribution of Learning Outcomes in Science Learning Fields

Cognitive Domain	Sub-Dimensions of Cognitive Domains	Content Domain			
		Earth and Universe	Living and Life	Physical Events	Matter and Nature
		% (f)	*% (f)*	*% (f)*	*% (f)*
1. Knowing	1.1. Recall/Recognize	33.3 (9)	7.4 (6)	6.1 (5)	14.2 (8)
	1.2. Describe	-	16.1 (13)	3.6 (3)	3.6 (2)
	1.3. Provide Examples	-	6.1 (5)	14.4 (12)	7.2 (4)
2. Applying	2.1. Compare/Classify	11.1 (3)	4.9 (4)	8.5 (7)	14.2 (8)
	2.2. Relate	-	1.3 (1)	1.2 (1)	5.4 (3)
	2.3. Use Models	18.5 (5)	11.1 (9)	7.2 (6)	1.8 (1)
	2.4. Interpret Information	-	1.3 (1)	-	5.4 (3)
	2.5. Explain	-	6.1 (5)	19.2 (16)	12.5 (7)
3. Reasoning	3.1. Analyze	11.1 (3)	19.7 (16)	14.4 (12)	10.7 (6)
	3.2. Synthesize	3.7 (1)	4.9 (4)	6.1 (5)	10.7 (6)
	3.3. Formulate Questions/Hypothesize/Predict	14.8 (4)	6.1 (5)	7.2 (6)	-
	3.4. Design Investigations	-	2.6 (2)	6.1 (5)	8.9 (5)
	3.5. Evaluate	-	3.8 (3)	1.2 (1)	1.8 (1)
	3.6. Draw Conclusions	7.4 (2)	8.6 (7)	4.8 (4)	3.6 (2)
	3.7. Generalize	-	-	-	-
	3.8. Justify	-	-	-	-
	Total	100 (27)	100 (81)	100 (83)	100 (56)

When Table 8 is examined, it is seen that the learning outcomes related to more cognitive domains overlap in the cognitive sub-dimensions of recalling-recognizing (33.3%) in the domain of knowing and using models in the domain of applying (18.5%) among the learning outcomes in the field of earth and universe learning. This is followed by the sub-dimensions of formulating question-hypothesize-predict (14.8%), comparing-classifying in the domain of applying (11.1%), and analysis in the domain of reasoning (11.1%). On the other hand, it is seen that more cognitive domain-related learning outcomes are included in the cognitive sub-dimensions of analysis in the domain of reasoning (19.7%) and definition in the domain of knowing (16.1%) within the learning outcomes in the domain of living and life learning. These sub-dimensions are followed by the use of models in the domain of applying (11.1%), drawing conclusions in the domain of reasoning (8.6%), and recalling-recognition (7.4%) in the domain of knowing. Among the learning outcomes in the domain of physical events, it is seen that there are more cognitive domain-related learning outcomes in the cognitive sub-dimensions of explaining in the domain of applying (19.2%), analyzing in the domain of reasoning (14.4%), and giving examples in the domain of knowing (14.4%). These dimensions are followed by the sub-dimensions of comparing-classifying in the domain of applying (8.5%), using models in the domain of applying (7.2%), formulating question-hypothesize-predict (7.2%) in the domain of reasoning. Among the learning outcomes in the domain of matter and nature learning, there are learning outcomes mostly related to the cognitive domain in the cognitive sub-dimensions of recalling-recognizing (14.2%) in the domain of knowing, comparing, classifying (14.2%) in the domain of applying (12.5%). These sub-dimensions are followed by analysis (10.7%), synthesizing (10.7%) and designing investigations (8.9%) in the domain of reasoning, respectively.

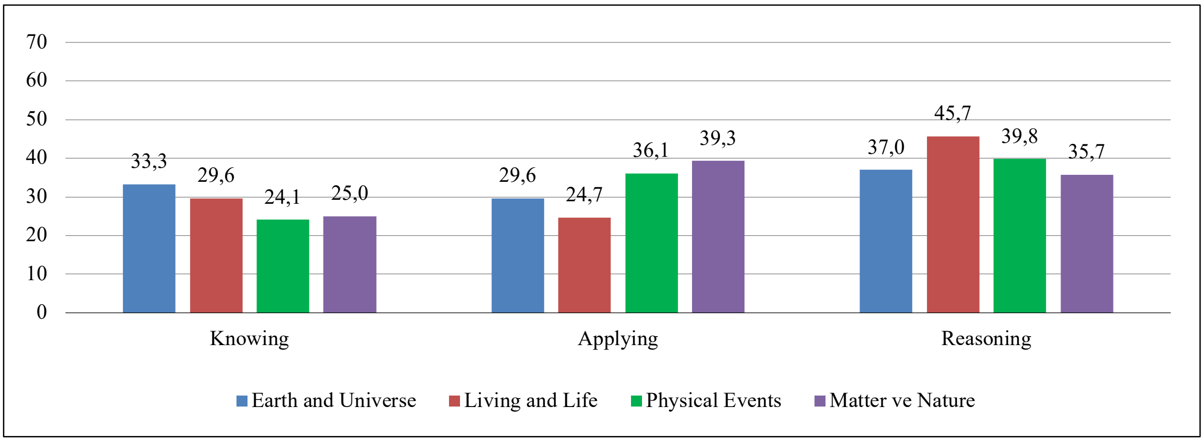

Figure 5. TIMSS Cognitive Domain Change of Learning Outcomes in Science Learning Fields

When Figure 5 is examined, it is seen that the majority of the learning outcomes in the field of earth and universe (33.3%) are within the cognitive domain of knowing among the learning outcomes in the middle school science curriculum. Similarly, a large proportion of learning outcomes related to living and life (29.6%), matter and its nature (25.0%) and physical events (24.1%) overlap with the cognitive domain of knowing. Nearly half of the learning outcomes (39.3%) in the field of matter and nature are within the applying cognitive domain. More than one-third of the physical events (36.1%) learning domain-related learning outcomes were associated with the cognitive domain of applying. In the learning domains of earth and the universe (29.6%) and living and life (24.7%), the learning outcomes related to the cognitive domain of applying were largely included. Finally, nearly half of the learning outcomes in living and life (45.7%) are within the cognitive domain of reasoning. In addition, a large proportion of the learning outcomes in the fields of physical events (39.8%), the earth and the universe (37.0%), and matter and nature (35.7%) are also in the domain of cognitive reasoning.

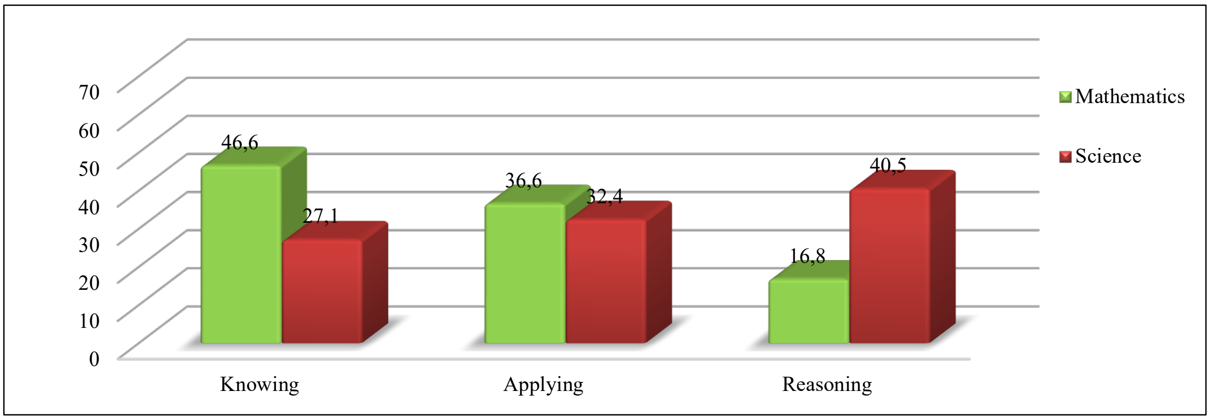

Figure 6. *Cognitive Domain Distribution of Learning Outcomes in Mathematics and Science Learning Fields*

When Figure 6 is examined, it is seen that 46.6% of the total learning outcome expressions in the mathematics curriculum are related to the cognitive domain of knowing, 36.6% to applying, and 16.8% to reasoning. In this context, while almost half of the learning outcomes in the mathematics curriculum are in the cognitive domain of knowing, low rates of learning outcomes are included in the cognitive domain of reasoning. On the other hand, it is seen that 27.1% of the total learning outcome expressions in the science curriculum are related to the cognitive domain of knowing, 32.4% to applying, and 40.5% to reasoning. Accordingly, while most of the learning outcomes in the science curriculum are related to the cognitive domain of reasoning, fewer learning outcomes are included in the cognitive domain of knowing.

DISCUSSION & CONCLUSION

In this study, according to the cognitive domain skills specified in the TIMSS-2019 evaluation frameworks, the learning outcome expressions in middle school mathematics and science curriculum were examined in terms of grade levels and learning domains. In this context, first of all, the learning outcome expressions at each grade level of the middle school mathematics curriculum were associated according to the TIMSS-2019 cognitive domain framework. More than one fifth of the learning outcomes in the fifth-grade level of the mathematics curriculum were in the sub-dimension of computing in the cognitive domain of knowing. The least associated learning outcome at this grade level is in the synthesizing subdimension of the cognitive domain of reasoning. At the sixth-grade level, there were more learning outcomes in the sub-dimension of computing in the cognitive domain of knowing. Less learning outcomes were associated with the evaluation sub-dimension in the cognitive domain of reasoning at this grade level. Similarly, at the seventh-grade level, while more learning outcomes were associated in the sub-dimension of computing of the cognitive domain of knowing fewer learning outcomes were associated in the sub-dimensions of recalling, retrieving, and classifying-ordering in the cognitive domain of knowing. The field where the most learning outcomes were associated with the eighth-grade level was the representing-modeling sub-dimension of the applying cognitive domain. The area where the least learning outcome was associated at this grade level was the classifying-ordering sub-dimension of the cognitive domain of knowing. On the other hand, it was determined that there was no learning outcome associated with the sub-dimensions of the reasoning cognitive domain, which are inference, generalization, and verification. According to these findings, it can be said that the majority of the learning outcomes in mathematics curricula are in the cognitive domain and sub-dimensions of knowing. The least learning outcomes are mostly found in the cognitive domain and sub-dimensions of reasoning. These findings differ with the explanations of the students, who are among the special objectives of the mathematics curriculum, for the development of metacognitive knowledge and skills (MoNE, 2018a). Therefore, the learning outcomes included in the mathematics curriculum should contribute to the development of students' high-level cognitive thinking skills and be able to move their reasoning skills further. However, the fact that the tasks in mathematics textbooks are mostly concentrated in the domain of cognition and applying makes it difficult for students to learning outcome high-level knowledge and skills (Yılmaz et al., 2021).

In addition, the findings of the study are in line with the findings of the study in which primary school mathematics curriculum learning outcomes are examined according to the TIMSS 2019 evaluation framework and fewer learning outcomes are associated with the domain of reasoning. (Delil et al., 2020). Similarly, it overlaps with the findings of the study in which it was determined that the learning outcomes were not sufficient at the metacognitive level in the middle education mathematics program (Çil et al., 2019). In this respect, it is necessary to include more learning outcomes in the domain of reasoning in both primary and middle school and middle school mathematics curricula. Because it is very important that mathematical knowledge is used to solve more complex problems and is integrated with other disciplines and daily life around values, skills, and competencies (Mullis et al., 2020). In addition, similar findings were obtained in the study in which the mathematics curriculum was examined according to the TIMSS 2015 evaluation framework. (İncikabı et al., 2016). One of the remarkable findings of the research is that the eighth-grade learning outcomes in the mathematics curriculum are mostly related to the applying cognitive domain. While this situation was in favor of the seventh-grade in the TIMSS-2015 evaluation, it changed in favor of the eighth-grade in the TIMSS-2019 evaluation (Incikabı et al., 2016). In the TIMSS 2019 evaluation of the primary school mathematics curriculum, more learning outcomes related to the applying cognitive domain were matched at the fourth-grade level (Delil et al., 2020). Based on these findings, individuals need to develop and implement mathematical thinking in order to overcome the problems they encounter in daily life (MoNE, 2018a). In this respect, considering that the learning outcomes play an important role in achieving the determined goals, it would be beneficial to associate the learning outcomes in mathematics curricula with the cognitive domain of reasoning.

Another finding obtained from the research was obtained from the distribution of learning outcomes of mathematics curriculum according to TIMSS-2019 cognitive domain skills. Accordingly, almost one-third of the learning outcomes in numbers and operations were associated with the sub-dimension of knowing, and computing in the cognitive domain. There are few learning outcomes associated with the synthesizing sub-dimension in the cognitive domain of reasoning. When the learning outcomes in the field of algebra were examined, it was determined that the most cognitive domain was related to the sub-dimension of computing, and the least cognitive domain was related to the sub-dimensions of recalling and determining the applying cognitive domain. When the learning field of geometry and measurement is examined, while there are more learning outcomes in the representation-modeling subdimension of the applying cognitive domain, fewer learning outcomes have been associated with the classification/ordering of the cognitive domain of knowing and with the evaluation sub-dimensions of the cognitive domain of reasoning. When the data processing learning field is examined, it has been determined that the highest number of learning outcomes is in the cognitive sub-dimensions of presentation-modeling in the applying domain and analysis in the reasoning domain. Finally, a total of six learning outcome expressions in the domain of probability learning, which are only included at the eighth-grade level, were associated with the sub-dimensions of recognition of the cognitive domain, inference by computing, determining, making, and presentation-modeling of the cognitive domain, reasoning and synthesis of the cognitive domain. According to these findings, it is noteworthy that the learning outcome expressions in the learning domains are mostly in the cognitive domain of knowing, and fewer learning outcome expressions are associated with the cognitive domain of reasoning. Another important finding of the research is that nearly half of the learning outcomes in the field of geometry and measurement are associated with the cognitive domain of applying. In addition, more than one-third of the learning outcomes in the domain of data processing has occurred in the cognitive domain of reasoning. More than half of the learning outcomes in the fields of numbers and operations and probability learning are concentrated in the domain of cognition. According to these findings, it can be said that as the cognitive level increases, the number of learning outcomes decreases. A similar finding was obtained in the study in which the questions in mathematics textbooks were examined according to TIMSS cognitive domains, and it was determined that there were few questions in the textbooks related to the cognitive domain of reasoning (Sümen, 2021). On the other hand, the findings obtained are similar to the results of the study examining the distribution of primary school mathematics curriculum according to TIMSS-2019 cognitive domains (Delil et al., 2020). In the study in which the learning outcomes were evaluated according to TIMSS-2015 cognitive domains, the learning outcomes within the fields of numbers and operations in the domain of cognition, algebra in the domain of applying cognition, and data processing in the domain of reasoning cognitive learning were more matched (Incikabı et al., 2016). In this context, it is noteworthy that the learning outcomes paired with cognitive domains differ according to learning domains. The most important reason for this situation is the different number of learning outcomes. For example, in the mathematics curriculum, more learning outcomes were included in numbers and operations, geometry, and measurement learning domains compared to other domains. In addition, while the probability learning field is only at the eighth-grade level, the learning outcomes related to the algebra learning field are not included in the fifth-grade curriculum. Especially the numbers and processes that require four processing skills and the high number of learning outcomes in algebra learning domains also affect the distribution in cognitive domains.

In the other step of the research, the learning outcome expressions at each grade level of the middle school science curriculum were associated according to the TIMSS-2019 cognitive domain framework. According to the findings, more than one-fifth of the learning outcomes at the fifth-grade level of the science curriculum are in the recalling-recognizing sub-dimension of the cognitive domain of knowing. Fewer learning outcomes have been matched in the sub-dimensions of reasoning, synthesizing, designing investigations, and evaluating the cognitive domain. At the sixth-grade level, the most learning outcome was in the definition sub-dimension of the cognitive domain of knowing, while the least learning outcome was in the inference sub-dimension of the cognitive domain of reasoning. At the seventh-grade level, the most learning outcome was in the sub-dimension of analyzing the cognitive domain of reasoning, while the least learning outcome was in the sub-dimension of associating the applying cognitive domain. When the eighth-grade level learning outcomes were examined, it was determined that the most learning outcomes were matched in the sub-dimension of analyzing in the cognitive domain of reasoning, and the least learning outcomes were matched in the sub-dimensions of interpreting knowledge in the cognitive domain of applying and evaluating in the cognitive domain of reasoning. According to these findings, it can be said that there is a partial increase in cognitive levels due to the increase in the grade level in the science curriculum. It is noteworthy that more learning outcomes related to the cognitive domain of reasoning are associated, especially at the eighth-grade level. On the other hand, while most learning outcomes related to the cognitive domain of applying are at the fifth-grade level, the distribution of the learning outcomes in the cognitive domain of knowing according to the grade levels is quite close to each other. On the other hand, it was determined that there was no associated learning outcome in the generalizing and justifying sub-dimensions of the cognitive domain of reasoning. According to these findings, it can be said that the science curriculum, which has been renewed due to the increase in grade levels, tries to focus on the learning outcomes that include more metacognitive skills. As a matter of fact, it is noteworthy that the Turkish MoNE tries to focus on the use of metacognitive skills, which are among the general objectives of the curricula, and to reflect the understanding of integration around skills and competencies in the learning outcomes (MoNE, 2018b). As the grade levels progress, while it is expected that the learning outcomes within the cognitive domains will progress at an increasing level, a homogeneous distribution is observed (Avcı et al., 2021). Although there are fewer questions and tasks related to metacognitive domains in textbooks and national exams, unlike TIMSS exams, it can be said that science curriculum learning outcomes have gathered momentum towards metacognitive levels (Bostan-Sarıoğlan et al., 2021; Böyük, 2017; Güven, 2014; Pedük, 2019; Pektaş et al., 2015; Sağlamöz & Soysal, 2021; Türkoğuz et al., 2019). Drawing attention to this situation, Avcı et al. (2021) emphasizes that as the grade level increases, the number of learning outcomes in the metacognitive knowledge subgroup should be increased.

Another finding obtained from the research was obtained from the distribution of learning outcomes of the science curriculum according to TIMSS-2019 cognitive domain skills. Accordingly, it has been determined that the learning outcomes in the field of earth and universe learning are distributed in a balanced way within the cognitive domains of knowing, applying, and reasoning. Nearly one-fifth of the learning outcomes in the field of living and life learning was associated with the sub-dimension of analyzing the cognitive domain of reasoning. At least, the applying was associated with the subdimension of interpreting information in the cognitive domain. While physical events are in the explanatory sub-dimension of the cognitive domain with the highest number of learning outcomes in the learning field, the least number of learning outcomes is in the sub-dimensions of associating cognitive domain and reasoning is in the sub-dimensions of assessment of cognitive domain. In the domain of matter and nature learning, the highest number of learning outcomes are in the domain of cognitive recalling-recognizing of the domain of cognitive knowledge is associated with the cognitive classifying-ordering dimensions of the domain of applying. While one-third of the cognitive domain of knowing includes learning outcomes in the earth and universe, more than one-third of the cognitive domain of applying consists of learning outcomes in the domain of matter and nature. One of the remarkable findings of the study is that nearly half of the cognitive domain of reasoning has been associated with learning outcomes in the field of living and life. According to these findings, it can be said that the learning outcomes in science learning domains do not show a balanced distribution and the number of learning outcomes at metacognitive levels is not at the desired level. Although it has been observed that the rates of learning outcomes allocated for students to experience higher cognitive demands remain low at all grade levels (Sağlamöz & Soysal, 2021), it is striking that the understanding that focuses on students' 21st-century learning skills tries to dominate in the renewed curricula. As a matter of fact, in the study conducted by Pedük (2019), it was concluded that reasoning learning outcomes are higher at the eighth-grade level. On the other hand, in the study conducted by Avcı et al. (2021), it is emphasized that the number of learning outcomes in the high-level steps is not sufficient and it is stated that it is important to develop more high-level cognitive skills with the constructivist approach adopted in the program. As a matter of fact, it has been stated that course learning outcomes have an important position in the development of scientific, life, engineering, and design skills, which are among the field-specific skills in the science curriculum of the Turkish MoNE (MoNE, 2018b). So, it is very important to revise the learning outcomes towards higher cognitive steps.

Finally, the learning outcomes included in mathematics and science curricula were examined according to their rates in TIMSS-2019 cognitive domains. According to the findings, among the total learning outcomes in the mathematics curriculum, there were the most learning outcomes associated with the cognitive domain of knowing, while the least learning outcomes were associated with the cognitive domain of reasoning. When the total learning outcomes in the science curriculum were examined, it was observed that the number of learning outcomes associated increased as they progressed towards metacognitive domains. In this context, while the most learning outcome was associated with the reasoning domain, the least learning outcome was associated with the cognitive domain of knowing. On the other hand, the learning outcomes in the curricula include more than one action. Therefore, it will be beneficial to make an arrangement from simple to complex in order to better understand the learning outcomes in the program and to prevent structural disorders (Kuzu et al., 2019). In addition, the learning outcomes in the cognitive domains should be included as more balanced. Because introducing individuals to learning outcomes at the level of applying and reasoning without having sufficient knowledge also restricts access to learning outcomes (Miller et al., 2008). Mathematics and science are the most effective branches of science in raising individuals with questioning, problem-solving, creative, critical, analytical, spatial, and logical thinking skills (Sarıer, 2020). Therefore, the learning outcomes in both mathematics and science learning should be qualified to serve the education of individuals with high-level knowledge and skills. For this, it is necessary to focus more on metacognitive learning outcomes in curricula. The learning outcomes concentrated in lower-level cognitive steps should change towards higher-level cognitive steps (Aktan, 2020). Otherwise, students are not provided with higher-level skills such as problem-solving, decision making, prediction, reasoning, logical and algorithmic thinking, which are a necessity of the 21st-century information age (Olkun & Toluk Uçar, 2014). In addition to all these statements, the study has certain limitations. The most important limitation of the study is that the obtained data consist of the learning outcomes in mathematics and science curricula. Another limitation is that the evaluation framework used in the study covers the TIMSS-2019 cognitive domains.

Suggestions

In the study, the learning outcome expressions in middle school mathematics and science curricula were examined according to the TIMSS-2019 evaluation frameworks. Similarly, primary and middle education programs can be handled according to the cognitive domains within the framework of TIMSS2019 evaluation and comparisons can be made. Not only mathematics and science curricula but also the learning outcomes of curricula at all levels of education can be analyzed according to this framework. Qualitative and quantitative studies can be conducted not only on the axis of curricula but also on the basis of teachers, students and textbooks and evaluations can be made according to cognitive domains. In addition, a contribution can be made to the relevant literature by comparing it with the results of this study. The quality of the learning outcomes in the curricula directly affects both the success of students in international exams and their metacognitive competencies. Therefore, the learning outcomes need to be updated to include more metacognitive skills. Utilizing the evaluation frameworks of international evaluation institutions (TIMSS, PISA, *etc.*) in the preparation of curriculum learning outcomes can open the door to both the development of an innovative understanding and the achievement of better results in exams. The target learning outcomes in the curricula of the countries that are successful in the TIMSS exam can be examined according to the cognitive domains of TIMSS and comparisons can be made with our curriculum.

Statements of Publication Ethics

Since the data of the study is not in the data group that requires ethical committee approval, it does not require ethics committee approval. The article has been prepared in accordance with research and publication ethics.

Researchers' Contribution Rate

Authors	Literature review	Method	Data Collection	Data Analysis	Results	Conclusion
Author 1	⊠	⊠	⊠	⊠	⊠	⊠
Author 2	⊠	⊠	⊠	⊠	⊠	⊠

Conflict of Interest

There is no conflict of interest in the study.

REFERENCES

Aktan, O. (2020). İlkokul matematik öğretim programı dersi kazanımlarının yenilenen Bloom taksonomisine göre incelenmesi [Investigation of primary school mathematics curriculum lesson acquisitions according to renewed Bloom taxonomy]. *Pamukkale University Journal of Education, 48,* 15-36. https://doi.org/10.9779/pauefd.523545

Avcı, F., Aslangiray, H., & Özyalçın, Ö. B. (2021). 2018 Fen Bilimleri öğretim programı kazanımlarının konu alanları ve sınıf düzeyi açısından yenilenmiş Bloom taksonomisine göre analizi ve değerlendirilmesi [Analysis and evaluation of the learning outcomes of the 2018 science curriculum according to revised Bloom taxonomy in terms of subject and class level]. *Trakya Journal of Education, 11*(2), 643-660. https://doi.org/10.24315/tred.689366

Baysura, Ö. D. (2017). *TIMSS matematik sorularının matematik öğretim programı ve TEOG matematik soruları kapsamında incelenmesi [An analysis of TIMSS mathematics items within the context of mathematics curriculum and TEOG mathematics items].* (Unpublished master's thesis). Yıldız Teknik University.

Birgin, O. (2016). Bloom taksonomisi [Bloom taxonomy]. In. E. Bingölbali, S. Arslan & İ. Ö. Zembat (Eds.), *Matematik Eğitiminde Teoriler [Theories in Mathematics Education]* (pp. 839-860). Pegem Academy Publishing.

Bostan-Sarıoğlan, A., Dolu, G., & Sevim, N. (2021). Sekizinci sınıf merkezi sınavlardaki fen sorularının TIMSS-2019 bilişsel alanları göre analizi [Analysis of science questions in eighth-grade central exams according to cognitive fields of TIMSS-2019]. *e-Kafkas Journal of Educational Research*, *8*, 514-533. https://doi.org/10.30900/kafkasegt.973021

Böyük, E. T. (2017). *Fen bilimleri dersi öğretim programının TEOG ve TIMSS sınavları kapsamında incelenmesi [An analysis of science curriculum within the context of TEOG and TIMSS exams].* (Unpublished master's thesis). Yıldız Teknik University.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2008). *Eğitimde bilimsel araştırma yöntemleri [Scientific research methods in education]* (25th ed.). Pegem Academy Publishing.

Centurino, V. A. S., & Jones, L. R. (2017). TIMSS 2019 science framework. In I. V. S. Mullis & M. O. Martin (Eds.), *TIMSS 2019 assessment frameworks* (pp. 29-55). Chestnut Hill.

Common Core State Standards Initiative (CCSSI) (2010). *Common core state standards for mathematics.* Retrieved November 12, 2021, from http://www.corestandards.org/Math/

Cotter, K. E., Centurino, V. A. S., & Mullis, I. V. S. (2020). Developing the TIMSS 2019 mathematics and science achievement instruments. In M. O. Martin, M. von Davier & I. V. S. Mullis (Eds.), *Methods and procedures: TIMSS 2019 technical report* (pp. 1-36). Chestnut Hill.

Çil, O., Kuzu, O., & Şimşek, A. S. (2019). 2018 ortaöğretim matematik programının revize Bloom taksonomisine ve programın ögelerine göre incelenmesi [Investigation of 2018 secondary mathematics curriculum according to the revised Bloom taxonomy and components of the program]. *YYU Journal of Education Faculty, 16*(1), 1402-1418. http://dx.doi.org/10.23891/efdyyu.2019.165

Delil, A., Özcan, B. N., & Işlak, O. (2020). İlkokul matematik dersi öğretim programı kazanımlarının TIMSS-2019 değerlendirme çerçevesine göre analizi [An analysis of Turkish primary school mathematics curriculum learning outcomes in terms of TIMSS-2019 assessment frameworks]. *Celal Bayar University Journal of Social Sciences, 18*(1), 270-282. https://doi.org/10.18026/cbayarsos.669086

Erdoğan, Z. (2020). *Ortaokul matematik dersi öğretim programı kazanımlarının TIMSS sınavı kapsamında incelenmesi ve 8. Sınıflar için destekleyici program önerisi [Analysis the learning outcomes of secondary school mathematics curriculum in the scope of TIMSS exam and a remedial program proposal for 8th graders].* (Unpublished master's thesis). Ankara University.

Feriver, Ş., & Arık, B. M. (2021). *Eğitim izleme raporu 2021: Eğitimin içeriği. Eğitim Reformu Girişimi [Training monitoring report 2021: The content of the training. Education Reform Initiative.].* Retrieved November 19, 2021, from https://www.egitimreformugirisimi.org/egitim-izleme-raporu-2021-egitimin-icerigi

Forster, N. (1995). The analysis of company documentation. In C. Cassell & G. Symon (Eds). *Qualitative methods in organizational research: A practical guide* (pp. 147-166). Sage Publishing.

Foy, P. (2017). *TIMSS 2015: User guide for the international database.* Chestnut Hill.

Güven, Ç. (2014). *6, 7, 8. sınıflar fen ve teknoloji dersi öğretim programındaki soruların yenilenmiş Bloom taksonomisine göre incelenmesi [The analysing of 6th, 7th and 8th grades science and technology lesson curriculum questions according to revised Bloom's taxonomy].* (Unpublished master's thesis). Ahi Evran University.

Hewitt, T. W. (2018). *Eğitimde program geliştirme: Neyi neden öğretiyoruz [Understanding and shaping curriculum: What we teach and why]*. (S. Arslan, Trans.), Nobel Academy Publishing.

Holroyd, C. (2022). Technological innovation and building a 'super smart' society: Japan's vision of society 5.0. *Journal of Asian Public Policy, 15*(1), 18-31. https://doi.org/10.1080/17516234.2020.1749340

Hooper, M., Mullis, I. V. S., & Martin, M. O. (2013). TIMSS 2015 context questionnaire framework. In I. V. S. Mullis & M. O. Martin (Eds.), *TIMSS 2015 Assessment frameworks* (pp. 61-82). Retrieved November 12, 2021, from https://timssandpirls.bc.edu/timss2015/downloads/T15_-Frameworks_Full_Book.pdf

İncikabı, L., Mercimek, O., Ayanoğlu, P., Aliustaoğlu, F., & Tekin, N. (2016). Ortaokul matematik dersi öğretim programı kazanımlarının TIMSS bilişsel alanlarına göre değerlendirilmesi [An evaluation of middle school mathematics teaching programs based on TIMSS cognitive domains]. *Elementary Education Online, 15*(4),1149-1163. https://doi.org/10.17051/io.2016.54792

Kılıç, H., Aslan-Tutak, F., & Ertaş, G. (2014). TIMSS merceğiyle ortaokul matematik öğretim programındaki değişiklikler [Changes in middle school mathematics curriculum through the lens of TIMSS]. *Mersin University Journal of the Faculty of Education, 10*(2), 129-141.

Kuzu, O., Çil, O., & Şimşek, A. S. (2019). 2018 matematik dersi öğretim programı kazanımlarının revize edilmiş Bloom taksonomisine göre incelenmesi [Investigation of 2018 mathematics curriculum objectives according to the revised Bloom taxonomy]. *Erzincan University Journal of Education Faculty*, *21*(3), 129-147. https://doi.org/10.17556/erziefd.482751

Lindquist, M., Philpot, R., Mullis, I. V. S., & Cotter, K. E. (2017). TIMSS 2019 mathematics framework. In I. V. S. Mullis & M. O. Martin (Eds.), *TIMSS 2019 assessment frameworks* (pp. 13-25). Retrieved November 23, 2021, from https://files.eric.ed.gov/fulltext/ED596167.pdf

Martin, M. O., Mullis, I. V. S., Hooper, M., Yin, L., Foy, P., & Palazzo, L. (2016). Creating and interpreting the TIMSS 2015 context questionnaire scales. In M. O. Martin, I. V. S. Mullis & M. Hooper (Eds.), *Methods and procedures in TIMSS 2015* (pp. 558-869). Chestnut Hill.

Miles, M, B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Publishing.

Miller, M. D., Linn, R. L., & Gronlund, N. (2013). *Measurement and assessment in* teaching (11th ed.). Pearson Education.

Ministry of National Education (MoNE) (2020). *TIMSS 2019 Türkiye ön raporu. Eğitim analiz ve değerlendirme raporları serisi [TIMSS 2019 Turkey preliminary report. Series of training analysis and evaluation reports].* Retrieved September 10, 2021, from http://timss.meb.gov.tr/www/raporlar/icerik/3

Ministry of National Education (MoNE) (2018a). *Matematik dersi öğretim programı (İlkokul ve ortaokul 3,4,5,6,7 ve 8. sınıflar) [Primary and middle school mathematics curricula for grades 3,4,5,6,7,8].* Retrieved September 10, 2021, from https://mufredat.meb.gov.tr/Programlar.aspx

Ministry of National Education (MoNE) (2018b). *Fen bilimleri dersi öğretim programı (İlkokul ve ortaokul 3,4,5,6,7 ve 8. sınıflar) [Primary and middle school science curricula for grades 3, 4, 5, 6, 7, 8].* Retrieved September 10, 2021, from https://mufredat.meb.gov.tr/Programlar.aspx

Ministry of National Education (MoNE) (2017). *Müfredatta yenileme ve değişiklik çalışmalarımız üzerine [On our work on curriculum renewal and change].* Retrieved September 10, 2021, from http://ttkb.meb.gov.tr/meb_iys_dosyalar/2017_07/18160003_basin_aciklamasi-program.pdf

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D., & Fishbein, B. (2020). *TIMSS 2019 international results in mathematics and science*. Chestnut Hill.

Mullis, I. V. S. (2017). TIMSS 2019: Monitoring trends in mathematics and science achievement. In I. V. S. Mullis & M. O. Martin (Eds.), *TIMSS 2019 assessment frameworks* (pp. 3-10). Chestnut Hill.

Mullis, I. V. S., Martin, M. O., & Loveless, T. (2016). *20 years of TIMSS: International trends in mathematics and science achievement, curriculum, and instruction.* Chestnut Hill.

National Council of Teachers of Mathematics (NCTM) (2014). *Principles to actions: Ensuring mathematical success for all.* Retrieved September 23, 2021, from https://www.nctm.org

National Research Council (NRC) (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics.* National Academies Press.

Olkun, S., & Toluk Uçar, Z. (2014). *İlköğretimde etkinlik temelli matematik öğretimi [Activity-based mathematics teaching in primary education]* (6th ed.). Eğiten Book Publishing.

Parlak, B. (2017). *Sekizinci sınıf öğrencilerinin TIMSS 2015 matematik başarılarının bilişsel tanı modeli ile incelenmesi [Investigation of TIMSS 2015 mathematics achievement for eighth-grade students with the cognitive diagnostic model].* (Unpublished doctoral dissertation). Hacettepe University.

Pedük, B. (2019). *Fen bilimleri dersi öğretim programının 2015 TIMSS ve 2018 LGS sınavları kapsamında incelenmesi [Examination of science education curriculum within the scope of 2015 TIMSS and 2018 LGS].* (Unpublished master's thesis). Manisa Celal Bayar University.

Pektaş, M., İncikabı, L., & Yaz, Ö. V. (2015). An analysis of middle school science textbooks in terms of TIMSS program framework. *Adıyaman University Journal of Educational Sciences, 5*(1), 29-48. https://doi.org/10.17984/adyuebd.08288

Sağlamöz, F., & Soysal, Y. (2021). 2018 ilköğretim fen bilimleri dersi öğretim programlarının kazanımlarının yenilenmiş Bloom Taksonomisi'ne göre incelenmesi [2018 Exploration of 2018 primary and elementary sciences course teaching programs outcomes according to the revised Bloom taxonomy]. *İstanbul Aydın University Journal of the Faculty of Education* 7(1), 111-145. https://doi.org/10.17932/IAU.EFD.2015.013/efd_v07i006

Sandelowski, M., & Barroso, J. (2007). *Handbook for synthesizing qualitative research.* Springer Publishing.

Saracel, N., & Aksoy, I. (2020). Toplum 5.0: Süper akıllı toplum [Society 5.0: Super smart society]. *Social Sciences Research Journal, 9*(2), 26-34.

Sarıer, Y. (2020). TIMSS uygulamalarında Türkiye'nin performansı ve akademik başarıyı yordayan değişkenler [Turkey's performance in TIMSS applications and variables predicting academic achievement]. *Journal of Primary Education, 2*(2), 6-27.

Sümen, Ö. Ö. (2021). Dördüncü sınıf matematik çalışma kitabında yer alan soruların TIMSS sınavı bağlamında incelenmesi [Examining the questions of the fourth-grade mathematics workbook in the context of TIMSS exam]. *International Journal of Society Researches, 18*(Special Issue), 4107-4125. https://doi.org/10.26466/opus.927449

TEDMEM. (2022). *2021 Eğitim değerlendirme raporu (TEDMEM Değerlendirme Dizisi 8) [2021 education evaluation report (TEDMEM Evaluation Series 8)].* Turkish Education Association.

Tekin, H. (2019). *Eğitimde ölçme ve değerlendirme [Measurement and evaluation in education]* (27th ed.). Yargı Publishing.

Türkoğuz, S., Balım, A. G., & Bardakçı, V. (2019). TIMSS 2011 Fen Bilimleri testinin 2016 İzmir ve 2011 Türkiye verilerinin karşılaştırılması [Comparison of 2016 İzmir and 2011 Turkey data by TIMSS 2011 Science test]. *Journal of the Human and Social Science Researches, 8*(1), 64-90. https://doi.org/10.15869/itobiad.469696

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2021). *Reimagining our futures together: A new social contract for education.* Retrieved December, 18, 2021, from https://reliefweb.int/

Yatağan, M. (2014). *Fen ve teknoloji dersi öğretim programının öğrenci ve öğretmen özelliklerine göre değerlendirilmesi: TIMSS 2007 ve 2011 verileri ile bir durum analizi [Evaluation of 2005 science and technology curriculum with respect to characteristics of students and teachers: a case analysis according to TIMSS 2007 and 2011 results].* (Unpublished doctoral dissertation). Gazi University.

Yıldırım, A., & Şimşek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri [Qualitative research methods in the social sciences]* (11th ed.). Seçkin Publishing.

Yılmaz, N., Ay, Z., & Aydın, Ş. (2021). An Investigation of tasks in the mathematics textbooks and objectives in mathematics curriculum from 4th to 8th grade related with data content domain according to TIMSS 2019 cognitive domains. *Cukurova University Faculty of Education Journal, 50*(2), 1397-1436. https://doi.org/10.14812/cuefd.745164