Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education
Vol. 20, Issue 1, June 2026, pp. 112-148. ISSN: 1307-6086
Research Article

Examination of the Tasks in the Mathematics Textbooks of Middle Schools in the Context of Mathematical Creativity*

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Received : 16.06.2025 Accepted : 12.01.2026

Doi: https://doi.org/10.17522/balikesirnef.1720683

Abstract – Creativity has emerged as a significant element in curricula developed over the past few years. Mathematical creativity is crucial for enabling individuals to take responsibility for their own learning, adapt to the rapidly changing global environment, and develop innovative thinking skills. In this context, creativity has been an important component of the curriculum developed over the past few years. Accordingly, textbooks designed for these curricula are expected to foster and enhance students' mathematical creativity. This study aimed to identify the potential of tasks in seventh and eighth-grade mathematics textbooks prepared in accordance with the 2013 and 2018 Middle School Mathematics Curricula to encourage mathematical creativity. Eight textbooks for 7th and 8th grades, published by the Ministry of National Education and private publishing houses in accordance with both curricula, were examined. Document analysis was used to evaluate the tasks (including problems, activities, and sample questions) in the textbooks. As a result, it was determined that textbooks prepared in accordance with the 2018 Middle School Mathematics Curriculum were more effective at fostering mathematical creativity. This study revealed which components of mathematical creativity are emphasized in textbooks and which need improvement. The results of this study are expected to be useful for educators and textbook authors. Furthermore, it can provide valuable information to curriculum development teams, improving instructional design and program effectiveness.

Keywords: Mathematical creativity, curriculum, textbooks, document analysis.

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*This article was prepared from a master's thesis written by the first author under the supervision of the second author. A part of this study was presented at the 16th National Science and Mathematics Education Congress (UFBMEK 2024).

Introduction

The development of technology has made it clear that there is a need to develop individuals who can explain problems encountered in many fields, such as engineering and natural sciences, where mathematics plays an important role, have questioning skills, and think critically and creatively (Schindler et al., 2018). These thinking skills, considered essential to develop, are considered 21st-century skills in national and international assessment studies. The International Society for Technology in Education (ISTE, 2007), one of the organizations that supports developing and disseminating 21st-century skills in education, ranks creativity and innovation first among the skills students need to develop (Larson & Miller, 2011).

In addition to having an important place in 21st-century skills, creativity is a complex subject to define, measure, or develop (Kirişçi & Kirişçi Sarıkaya, 2023). Creative thinking involves finding different solutions and interpretations, making different mathematical connections, applying different techniques, and original, unconventional thinking (Leikin, 2011). In the 21st century, students' learning how to learn will become a much more important skill for the problems they face in school and everyday life (Adams & Hamm, 2010). Therefore, fostering creativity in educational settings has become essential today.

The factors that support the development of these skills in the school environment include teachers, course materials, and the school environment. According to Rotherham and Willingham (2010), without improved curricula, more effective teachers, and enhanced assessment resources, it is difficult to equip students with 21st-century skills. Well-designed textbooks allow students to develop their ways of thinking, have different perspectives, and provide original answers to problems. Therefore, contemporary textbooks must be enriched with content that promotes creative thinking and mathematical creativity, both essential skills for the 21st century.

The literature on mathematical creativity shows that there are various studies on creativity and mathematical creativity, and these studies generally appear as the development of scales to measure creativity or mathematical creativity (e.g., Akgül & Kahveci, 2016; Özgenel & Çetin, 2017; Sezerel, 2019), research on measuring mathematical creativity levels between gifted and non-gifted students (Assmus & Fritzlar, 2022). However, it is important to consider what kind of guidance there is for mathematical creativity in the curriculum and how and to what extent tasks are included in the textbooks prepared based on these. Studies

examining mathematical creativity in curricula can be found in the literature (Bicer et al., 2021; Bicer et al., 2024; Hadar & Tirosh, 2019; Mylina et al., 2023). In Türkiye, however, such studies are scarce (Altuner Sözeri et al., 2023; Özgür & Doğan, 2019). Altuner Sözeri et al. (2023) analyzed how 7th-grade textbooks support mathematical creativity using the DISCOVER matrix. However, it is not sufficiently known to what extent textbooks taught at different grade levels in our country, prepared by various publishers, support mathematical creativity. Therefore, this study aims to investigate how mathematical creativity is addressed in middle school mathematics textbooks under the 2013 and 2018 middle school mathematics curricula (MMC) and the changes in this process. In this context, mathematics textbooks' tasks (problems, exercises, and activities) were analyzed in relation to mathematical creativity based on a specific conceptual framework. The data shows which grade-level tasks that promote mathematical creativity are more likely to be found in textbooks and which categories of tasks that develop mathematical creativity are distributed. In addition, textbooks prepared according to the 2013 (MoNE, 2013a) and 2018 MMC (MoNE, 2018a) were compared to draw inferences about the grade levels and categories that encourage creativity. To this end, the following research questions were addressed.

1. What is the presence of tasks that encourage mathematical creativity in middle school mathematics textbooks according to grade level?

2. How are tasks that encourage mathematical creativity distributed according to the components of mathematical creativity?

3. How are tasks that involve mathematical creativity distributed according to learning areas in MMC?

Literature Review

General Creativity and Mathematical Creativity

A literature review on the concept of creativity reveals that a clear definition remains elusive, and it is challenging to provide a precise definition (Sriraman, 2009). Some researchers attribute the difficulty of defining creativity to the existence of multiple interpretations and the absence of a single, universally accepted definition (Idris & Nor, 2010; Mann, 2006). In addition, other scholars argue that these diverse definitions do not contradict but rather complement one another (Rhodes, 1961). Beyond the challenges of definition, researchers also hold varying perspectives on the meaning, measurement, evaluation, and development of creativity. The fact that creativity has an interdisciplinary use is also seen as

one of the difficulties in its definition (Akgül & Kahveci, 2016). However, creativity is generally seen as more related to the concepts of "genius" or giftedness; looking at it from a broader perspective as educators make it easier for us to follow more productive paths for all students (Silver, 1997). For this reason, creativity is a high-level thinking skill that considers the concept practically, can provide accurate and fast solutions to problems with more flexible solutions, and can give original answers (Silver,1997; Torrance, 1974).

There are accepted dimensions in studies on indicators of creativity. While Guilford (1967) associated creativity with divergent and convergent thinking, Torrance (1974) defined four components in the creativity measurement tests known by his name. These are fluency, flexibility, originality, and elaboration. As shown in Figure 1, fluency refers to the number of correct answers given to a problem. Flexibility involves using different solution methods, originality concerns producing unique and unusual ideas, and elaboration refers to explaining and developing these ideas through appropriate generalizations.

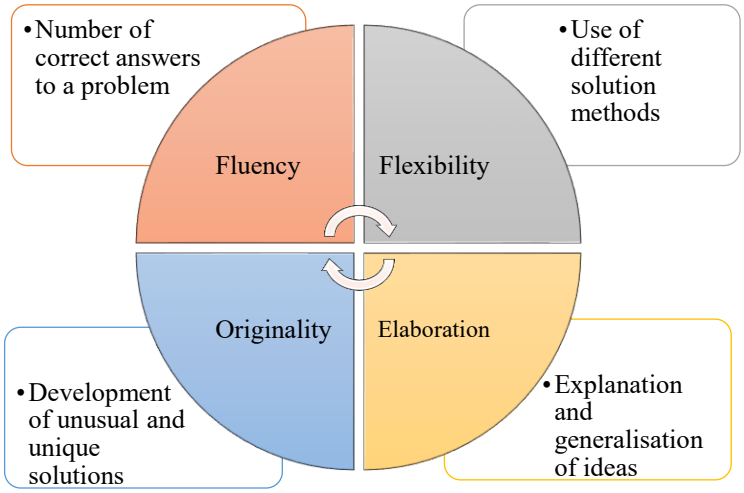


Figure 1 Indicators (Dimensions) of Creativity

Since a universally accepted definition of creativity does not exist, a precise and straightforward definition of mathematical creativity remains elusive. (Haylock 1987; Nadjafikhah et al., 2012). Joklitschke et al. (2019), who conducted a systematic literature review of studies on the concept of creativity in mathematics education between 2007 and 2019, focused on five dominant concepts of creativity: 1) creativity as fluency, flexibility, originality and elaboration, 2) creativity as divergent thinking (Guilford, 1967), 3) creativity

as a set of stages (e.g. Ervynck, 1991), 4) creativity from the perspective of person, process, and product, and 5) creative mathematical reasoning.

According to Ervynck (1991), who states that mathematical creative thinking has stages; the level of creativity increases from stage 0, which starts with preliminary preparation, to stage 2. Stage 0 can be likened to a craftsman preparing to perform his art. In the mathematical context, having the necessary prior knowledge can be seen as the basic and first stage of creativity. The following stages include the processes by which mathematical operations are performed. These processes include algorithmic activities, such as calculating the value of a polynomial or factoring algebraic expressions, and lead to a transition to an advanced stage where creative mathematical activities are performed.

Developing Mathematical Creativity

If the aim is to develop individuals' creativity in a specific discipline, it should be aimed to develop discipline-specific creativity rather than general creativity (Bicer et al., 2020). Therefore, developing mathematical creativity, the discipline-specific reflection of creativity, helps students improve their mathematical thinking skills and better sense of mathematical concepts (Bruhn & Lüken, 2023). When the components of mathematical thinking are considered, it is possible to develop creativity (Sriraman et al., 2011). Still, this development process needs time and experience since it involves the processes of associating the information learned with previous learning and developing strategies (Mann, 2006). Development is likely to be realized not suddenly but through interactions.

Learning environments that foster mathematical creativity can be both in-class and out-of-class. Out-of-school environments, such as family, environment, relatives, etc., are the elements that are not directly involved in the teaching phase but enable the development of mathematical creativity. Classroom environments, on the other hand, are situations in which students learn new mathematical knowledge and use what they have learned. Teaching materials are among the most important factors in the classroom environment. Instructional materials are all kinds of tools and equipment, handmade materials, written or oral resources, the internet, etc., that are used in mathematics teaching. Among these materials, textbooks are the sources that allow students to access information directly and quickly. In our country, textbooks are printed materials that every student has easy access to, and they are used in all educational institutions. The fact that the tasks included in these textbooks support the

development of mathematical creativity demonstrates their consistency with the 21st-century skills emphasized in the curriculum.

A review of the literature reveals that the types of tasks that encourage mathematical creativity primarily include problem-solving and problem posing, problems with multiple solution paths, and open-ended questions (e.g., Leikin, 2009; Rahayuningsih et al., 2021). Kozlowski et al. (2019) stated that to encourage mathematical creativity, teaching approaches should include problem-solving and problem-posing, presenting problems that require mathematical modelling, including problems with multiple solutions, and open-ended problems that allow students to generate more than one correct answer. According to Pitta-Pantazi et al. (2018), who stated that inquiry-based education, an exploratory educational environment, multiple solution tasks, everyday life scenarios, and problem-solving activities are involved in the emergence or development of mathematical creativity, it is important to include technology-supported education that develops students' mathematical creativity in class and reflective learning environments where communication among students is intense. Additionally, collaborative learning environments enable students to express their ideas freely and foster their social learning through a shared sense of group consciousness. Research has demonstrated that collaborative learning is more effective than individual learning for fostering creative thinking (e.g., Segundo-Marcos et al., 2023). Additionally, findings suggest that mathematical creativity emerges when students exchange ideas with one another (Mann, 2005), indicating that group work on mathematical tasks can significantly enhance students' mathematical creativity.

One important way to develop mathematical creativity in students is to encourage them to think deeply. Deep thinking improves individuals' analytical and predictive abilities (Dağlıoğlu & Çakır, 2007). It contributes to making generalizations and abstractions, viewing mathematical concepts from a broader perspective (Tall, 1991). Justification, defined as a method for determining and explaining the validity of a conjecture or assertion (Ayala-Altamirano & Molina, 2021), promotes students' reflection on their ideas and facilitates their understanding and active engagement in the development of mathematical concepts and processes (Chua, 2016). Notably, justifications do not always need to be logically complete (Jaffe, 1997). This shows that justifications can be used from primary school to develop students' content knowledge and reasoning skills (Thanheiser & Sugimoto, 2022).

Another factor in the classroom environment is the teacher. The teacher's attitude towards creativity is closely related to the ability of the learning environment to support mathematical creativity. There is limited evidence on the quality of teachers' assessments of their students' creativity (Gralewski & Karwowski, 2019). If the teacher's attitude towards mathematical creativity is incorrect, it is difficult for mathematical creativity to develop in that environment (Mann, 2005). In this regard, textbooks, which teachers frequently use for in-class activities, are expected to serve as a guide for teachers. Having tasks in textbooks that encourage students' mathematical creativity will encourage teachers to utilize textbooks more effectively.

Mathematical Creativity in Curricula

From the past to the present, curricula increasingly emphasize the need for a student-centered approach to education. In the 1990 curriculum, it can be seen that students' problem-solving, critical, and creative thinking skills have started to be given importance (Özmantar et al., 2020). Due to the widespread adoption of student-centered education and the rapid development of technology, high-level thinking skills seem essential. The development of creative thinking, one of the thinking skills highlighted by 21st-century skills, is also included in the curricula. The 2009 MMC in Türkiye included expressions of creative thinking, and especially the 2018 MMC included expressions of metacognitive skills, reasoning, and research, which indirectly emphasize creativity. In the 2013 MMC, the focus on communication, reasoning and association skills within the mathematical process skills can be partially related to mathematical creativity, albeit indirectly. Creativity was included as a theme under the title 'Trends' in the renewed curriculum, the Türkiye Century Education Model (MoNE, 2024), and also under seven different themes in the MMC. In addition, suggestions have been made on teaching and learning practices to promote the development of creative thinking. In this respect, it differs from other curricula. The comparison of the inclusion of creativity in the new curriculum and the previous curricula is given in the discussion section.

Curriculum support is very important for the development of creativity. Hadar and Tirosh (2019) emphasized that to develop students' creativity, the curriculum should be designed accordingly. Textbooks, which are produced according to the curricula, should also be designed in such a way that they can contribute to this process. Camphell and Jane (2010), in their study on whether creativity can be taught and developed, found that it can be developed mainly in the curriculum and when students use technology effectively in their

lesson plans in classroom learning environments. In this respect, the materials presented to students and the curricula that are the source of the preparation of these materials should be designed in such a way as to enable the development of mathematical creativity.

Tasks

Tasks refer to the entirety of expected problems, research, activities, or sample questions that involve students researching, expressing their ideas, analyzing problems, and understanding them. According to the NCTM 2020 report, mathematical tasks serve as tools to develop students' various skills and introduce mathematical concepts (Martins & Martinho, 2024). Therefore, mathematical tasks are at the center of learning and teaching (Johnson & Ohtani, 2025). In this study, the tasks cover those in the textbook. However, a task encompasses not only the content in textbooks but also everything the teacher expects students to think about during the lesson (Watson & Ohtani, 2015). In this study, tasks refer to all exercises, activities, and research questions, including solved examples in mathematics textbooks. In other words, they are all the mathematical tasks the student encounters in the textbook. Sample tasks are included in the data analysis section, along with the operational use of categories that support mathematical creativity in this study. Examples of tasks for each category can also be found in Appendix 1.

Method

This study used document analysis, one type of qualitative research method. Document analysis involves analyzing and evaluating all types of printed or non-printed sources (e-books, web pages, books, encyclopedias, computer-based resources, etc.) using specific procedures (Bowen, 2009). It allows accurate results to be obtained from primary and reliable sources.

The documents of this study consist of textbooks produced according to the MMC of 2013 and 2018. We analyzed four textbooks for seventh and eighth grade. Two of the textbooks at each grade level were prepared by the Ministry of National Education (MoNE), and private publishers (PP) prepared the other two. The reason for choosing these grade levels is that the relevant learning areas in these two grades are closer to each other in the transition phase of students to primary education. This approach assesses the comparative status of textbook tasks in fostering mathematical creativity across different grade levels.

Data Collection

The data source consists of 8 books from two publishers, prepared according to the 2013 and 2018 MMC guidelines for 7th and 8th grade levels (MoNE, 2013a, 2013b, 2013c, 2018a, 2018b, 2018c). The textbooks were coded based on curriculum year, and grade level (e.g. MoNE-2013- 7^{th}, PP-2018-8^{th});full bibliographic information for all analyzed textbooks is provided in the references. Tasks were selected by prioritizing learning areas common to both grade levels, ensuring a basis for meaningful comparisons. These are numbers and operations, geometry and measurement, algebra, and data processing. The only one not included is probability. This is because, at the level of grade 7, this learning area is not included in either curriculum. The distribution of the 200 tasks by learning areas was determined according to the percentage of course hours in the curriculum. For example, in the 2018 curriculum, since the Numbers and Operations learning area corresponds to approximately 44% of the total course hours, 44% of the 200 tasks, i.e. 88 tasks, were selected from this learning area (see Table 1). This distribution was made according to the number of lesson hours rather than the number of learning outcomes because not all learning outcomes contain the same learning intensity.

Table 1 Distribution of the Number of Tasks Analyzed from Textbooks According to Learning Areas

	7^{th} Grade (2013)	7^{th} Grade (2018)	8^{th} Grade (2013)	8^{th} Grade (2018)
Numbers and operations learning area	88 tasks	110 tasks	64 tasks	58 tasks
Geometry and measurement learning area	70 tasks	40 tasks	70 tasks	60 tasks
Algebra learning area	28 tasks	34 tasks	58 tasks	66 tasks
Data processing learning area	14 tasks	16 tasks	8 tasks	16 tasks
Total	200 tasks	200 tasks	200 tasks	200 tasks
Total of both publishers	400 tasks	400 tasks	400 tasks	400 tasks

All tasks in the textbooks are numbered starting from 1 for each learning area separately. Thus, the number of tasks in each textbook was determined according to the learning areas. As shown in Table 1, the tasks were selected from the textbooks according to the number of tasks. In order to avoid any possible bias, the selection of tasks was done using the "random" formula in the Microsoft Excel program. The aim was to select tasks

representing the overall structure of the book using a random sampling method. Thus, instead of examining all the tasks in the textbooks, approximately one-third of the tasks (ranging from 30% to 35%) were selected for examination. In qualitative research, it has been suggested that analyzing data after reaching saturation is a waste of resources and time. (Creswell, 2014). Data saturation was reached, as evidenced by the recurrence of themes and coding in the books. Furthermore, by selecting tasks based on specific learning areas (refer to Table 1), the objective was to avoid choosing tasks from the same themes within the textbooks. A comprehensive analysis was conducted on a total of 1,600 tasks, with 200 tasks selected from each textbook, focusing on components that foster mathematical creativity (see Table 2).

Table 2 Task Categories of Mathematical Creativity

Open-ended problems	Problem-posing	Connections	Visualizations	Extensions	Communication
Multiple Solution Paths	Structured	Real Life	Technology Integration	Harder/Challenging Problem	Group work
Incomplete Problems	Semi-Structured	Inter-disciplinary	Hands-on Materials	Generalization	Reflective Question
More than One Correct Answer	Free	Within Mathematical Topics	Drawings	Justification	
Modelling					

Analysis of Data

The conceptual framework used in the research was used in the analysis of the textbooks by adding one more category (*subcategory of "Justification"*) to the conceptual framework used in the study of Bicer et al. (2021) (see Table 2). Bicer et al. (2021) extended the framework used in the study of Hadar and Tirosh (2019) and used it in their study. This framework has been used because it allows for a more in-depth examination of the tasks in textbooks, taking into account the dimensions of mathematical creativity (*fluency*, *flexibility*, *originality*, and *elaboration*). Table 2 shows the conceptual framework, which consists of 6 main categories and 18 subcategories related to these main categories. Sipahi and Bahar (2025) highlight that to uncover the depth and multidimensional nature of mathematical creativity, it is essential to focus on tasks that require justification. Furthermore, when analyzing textbooks, the presence of statements such as "explain why," "evaluate the result,"

and "explain with reasons" in the tasks encountered has revealed the need for a theme around which these tasks can be coded, as they direct students towards verification. Therefore, in the conceptual framework, the subcategory "justification" was added to the main category "extensions" to finalize it.

To assess how the 1,600 tasks foster mathematical creativity, each subcategory in Table 2 was evaluated. At this stage, if a task was related to any subcategory, it received 1 point; if not, it received 0 points. The total score for the main category was obtained by summing these points. For example, if a task involved both real-life situations and an interdisciplinary approach, the score for that task in the association category was calculated as 2.

To ensure the reliability of data analysis, special attention was paid to inter-coder agreement. Initially, the authors identified and examined approximately 5% of the tasks from various learning areas separately, after which they compared the codes. Each task was examined and discussed separately until an agreement was reached regarding the different coding approaches. Once consistency was achieved in all tasks, the analysis of the remaining tasks continued.

Components of the Framework

Open-ended tasks/problems

Open-ended problems aim to deepen students' mathematical knowledge and develop their creative mathematical thinking, embracing that not every problem has a single solution or correct answer (Klavir & Hershkovitz, 2008). With such problems, students can question the effectiveness and appropriateness of solutions rather than finding multiple solutions (Olkun & Uçar, 2009). This category consists of four subcategories: problems with multiple solution paths, problems with more than one correct answer, modeling tasks, and incomplete problems. When coding tasks related to this category in textbooks, it is essential to consider the tasks and their solutions together.

It is expected that problems with multiple solution paths can be addressed using various strategies, methods, and approaches. For example, when asked which natural number is closest to the square root of 23, the student may solve the problem algebraically or visualize it on a number line. Tasks with more than one correct answer do not involve a variety of solution paths, but rather tasks where there are multiple correct answers. An example of this type of task is "Draw a triangle with an area of 36 square centimeters." Incomplete problems are intentionally left unfinished, with the expectation that participants

will complete them or clarify any uncertainties. In these tasks, students may also be asked to finish partially completed solutions. These tasks encourage participants to develop their analytical and flexible thinking skills, as well as their problem-solving abilities. For example, it is expected that a graph of a given line be drawn accurately within a specific interval so that it remains valid for all real numbers. Additionally, students should complete the constant term in a given quadratic equation to determine the solution set. Mathematical modeling stands out as a process that encourages creativity, and the development of modeling skills can enhance creativity (Lu and Kaiser, 2022; Wessels, 2014). Tasks that require modeling can be expressed using representations such as equations, graphs, and tables to illustrate real-life situations.

Problem-posing

According to the approaches of Stoyanova and Ellerton (1996), who created the problem-posing framework, they divided them into three categories: structured, semi-structured, and free/unstructured. While structured problem-posing activities are based on a specific problem or solution with clearly drawn boundaries, free problem-posing activities are based on the subject or figure related to this subject, etc., without giving any data or solution. These are activities in which students are asked to pose problems. Semi-structured problem posing is a situation where students are given a problem situation, first, discover the structure of this problem, and then pose new problems that will improve this problem (see Figure 2) (Van Harpen & Sriraman, 2013).

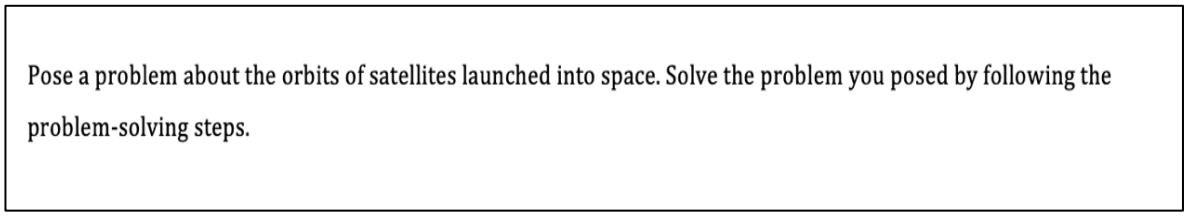


Figure 2 Example Task from the 7th grade PP-2013 Middle School Mathematics Textbook in the Free Problem-Setting Category (Aydın & Beşer, 2013)

Connection/connected tasks

Making mathematical connections is the cognitive process of connecting mathematics with concepts, definitions, theorems or representations, other disciplines, and real life (Dolores-Flores et al., 2018). For this reason, the tasks in the textbooks related to this category were examined in three subcategories. Connection within mathematics subjects is

interdisciplinary connection and connection with real life. Relating mathematical concepts involves using previously learned mathematical knowledge to solve a problem. For example, when solving problems that involve square roots and where the sides of a triangle are expressed as square root values, students need to understand the properties of operations with square roots. They also need to know how to calculate the area of a triangle, both of which they should have learned in previous years. Interdisciplinary connection entails designing a mathematical task by integrating elements from other scientific disciplines (see Figure 3).

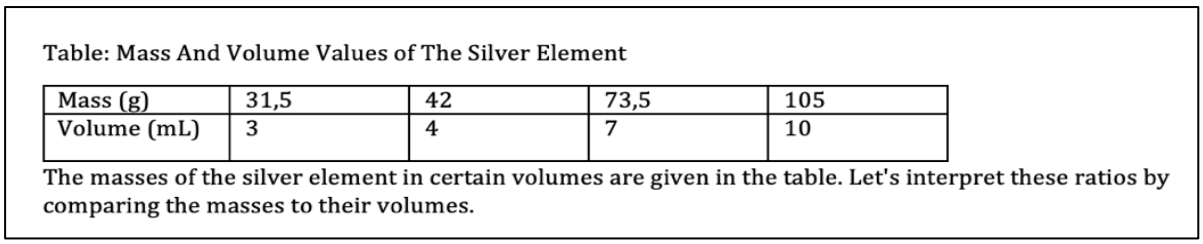


Table: Mass And Volume Values of The Silver Element

Mass (g)	31,5	42	73,5	105
Volume (mL)	3	4	7	10

The masses of the silver element in certain volumes are given in the table. Let's interpret these ratios by comparing the masses to their volumes.

Figure 3 Example of Interdisciplinary Linking Tasks (MoNE, 2018b)

Tasks in the real-life connection category involve everyday problems that offer opportunities to illustrate abstract concepts. For instance, the topic of ratios and proportions can be effectively taught by using the example of the ratio of water to lemons required to make lemonade.

Visualization

Visualization tasks involve effectively teaching mathematical operations, rules, or concepts using drawings, handmade materials designed to help students internalize abstract concepts or rules, and technology. Research on the development of creative thinking in mathematics points to the importance of exposing students to problems involving visualization in mathematical activities (Campbell & Jane, 2010; Idris & Nor, 2010; Schindler & Lilienthal, 2020). In this regard, the problems in the drawing category in this study were examined in terms of their ability to represent concepts more effectively through drawing. For example, tasks such as providing the student with coordinates without giving them a pre-made parallelogram shape to draw themselves and make assessments based on this drawing, represent this category. Handmade manipulatives are activities that help students grasp mathematical concepts using tools like paper, pencils, scissors, glue, and rulers. These activities can be designed for both group and individual work (see Appendix 1).

Extensions/extendable tasks

The extensions category includes challenging problems, generalization, and justification subcategories. In this study, challenging problems are tasks that require students to think at a higher level and are not included in the learning outcomes for their grade level. However, through research, students can take individual responsibility for their own learning. Examples of challenging problems that can be evaluated in this category include tasks that require high-level cognitive demands, such as finding multiple methods to calculate the area of a triangle. Tasks involving generalization require applying the rules given for specific situations to different situations, such as identifying a pattern rule and explaining why it works. Justification tasks involve determining whether something is correct, explaining why it is correct, and how it is correct—for example, verifying a given solution to a problem and explaining why it is correct or incorrect.

Communication

In terms of developing 21st-century skills, a student-centered approach to teaching emphasizes students working together, thinking and collaborating on an original problem (Rotherham & Willingham, 2010). The inclusion of group work in the classroom to create a collaborative working environment and reflective questions that encourage students to solve problems by sharing their thinking with their peers fall into this category. Tasks in the communication category in textbooks should include instructions such as “form a group” and “discuss with your friends.” In these teaching activities, where students can learn from one another, the teacher should manage the class like an orchestra conductor, creating an environment where students have more say. Tasks that support the creation of this environment have been evaluated in this category.

Findings

A total of 200 tasks were randomly selected from each analyzed textbook. The overall number of tasks examined across all books is 1,600. These tasks pertain to the learning areas of numbers and operations, geometry and measurement, data processing, and algebra. Six main categories and 18 subcategories belonging to these categories were coded and their percentages were calculated. This section summarizes the findings related to the framework categories used in the research. Furthermore, sample tasks from textbooks that focus on relevant categories (18 subcategories that promote mathematical creativity) are included in Appendix 1.

General Findings for the Main Category with Curricula

In the 2013 MMC, the summed averages (MoNE and PP) were 11.25% in the open-ended problem category, 3.75% in the problem-posing category, 55% in the connection category, 31.50% in the visualization category, 17.75% in the extensions category, and 17.5% in the communication category. According to the data obtained from the 2018 MMC textbooks, the summed averages (MoNE and PP) were 16.25% in the open-ended problem category, 0% in the problem-posing category, 73% in the connection category, 19.75% in the visualization category, 20.5% in the extensions category, and 11.5% in the communication category (see Table 3). According to these results, the task categories with an increase from 2013 to 2018 are open-ended problems, connection tasks, and extension tasks. The categories with a decrease are problem posing, visualization, and communication.

Table 3 Distribution of Percentages for Main Categories and Subcategories in Textbooks

		2013 Mathematics Curriculum in Middle Schools						*2018 Mathematics Curriculum in Middle Schools*					
		7th Grade			8th Grade			7th Grade			8th Grade		
		MoNE (%)	PP (%)	AVERAGE (%)	MoNE (%)	PP (%)	AVERAGE (%)	MoNE (%)	PP (%)	AVERAGE (%)	MoNE (%)	PP (%)	AVERAGE (%)
Open-Ended Problems	Multiple Solution Paths	3.5	2	2.75	1	3	2.00	3	2.5	2.75	0.5	2.5	1.50
	More than One Correct Answer	2	0.5	1.25	0	2	1.00	2	0.5	1.25	4.5	0,5	2.50
	Modeling	2	1.5	1.75	2	1.5	1.75	4.5	0	2.25	7.5	3.5	5.50
	Incomplete Problems	0.5	1	0.75	0	0	0.00	0	0.5	0.25	0	0.5	0.25
	Total	8	5	6.50	3	6.5	4.75	9.5	3.5	6.50	12.5	7	9.75
Problem-posing	Structured	1.5	1.5	1.50	0	0.5	0.25	0	0	0.00	0	0	0.00
	Semi-Structured	2.5	1	1.75	0	0	0.00	0	0	0.00	0	0	0.00
	Free	0	0.5	0.25	0	0	0.00	0	0	0.00	0	0	0.00
	Total	4	3	3.50	0	0.5	0.25	0	0	0.00	0	0	0.00
Connections	Real Life	27.5	22	24.75	16.5	21	18.75	23.5	38.5	31.00	21.5	38.5	30.00
	Inter-disciplinary	2.5	2	2.25	2	0	1.00	1	3	2.00	0	3	1.50
	Within Mathematical Topics	2.5	2	2.25	9	3	6.00	2	3.5	2.75	8	3.5	5.75
	Total	32.5	26	29.25	27.5	24	25.75	26.5	45	35.75	29.5	45	37.25
Visualizations	Technology Integration	1	0.5	0.75	1	3	2.00	2	0	1.00	2.5	0	1.25
	Hands-on Materials	3.5	7.5	5.50	2	7	4.50	2	4.5	3.25	1	4.5	2.75
	Drawing	3.5	7	5.25	10.5	16.5	13.50	1.5	5.5	3.50	10.5	5.5	8.00
	Total	8	15	11.50	13.5	26.5	20.00	5.5	10	7.75	14	10	12.00
Extensions	Harder/Challenging Problem	0.5	1.5	1,00	1	2	1.50	1	0.5	0.75	1.5	0	0.75
	Generalizations	1.5	4	2.75	4	2.5	3.25	11.5	2.5	7.00	3	2.5	2.75
	Justification	2.5	6	4.25	5	5	5.00	4.5	6.5	5.50	1	6.5	3.75
	Total	4.5	11.5	8.00	10	9.5	9.75	17	9.5	13.25	5.5	9	7.25
Communication	Group Work	0.5	3	1.75	0	2	1.00	0	0	0.00	0	0	0,00
	Reflective Question	7.5	14,5	11.00	7	0.5	3.75	2.5	8	5.25	4.5	8	6.25
	Total	8	17.5	12.75	7	2.5	4.75	2.5	8	5.25	4.5	8	6.25

Findings Related to the Category of Open-Ended Questions

The subcategories of the 'open-ended problems' category are multiple solution paths, problems with more than one correct answer, modeling, and incomplete problems. When examining the distribution of tasks related to open-ended problems across eight textbooks, a notable concentration is observed in the 8th grade textbooks prepared in accordance with the 2018 middle school mathematics curriculum. In particular, incomplete problems and modeling categories are concentrated in the textbooks for this grade level and curriculum. Although this is expected, both curricula show the same average percentage (3.5%) of tasks involving multiple solution paths at the 7th grade level. (see Table 3).

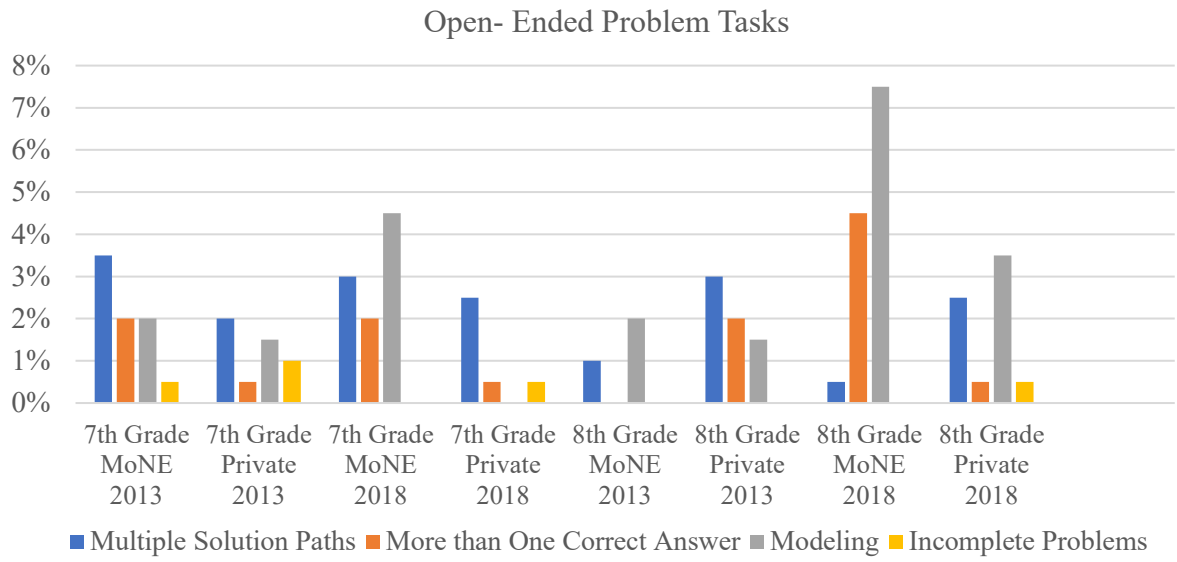


Figure 4 Percentages of Tasks in the Open-Ended Problems Category in Textbooks

As shown in Figure 4, the increase in tasks requiring modeling in 2018 mathematics textbooks is particularly noteworthy. These tasks have frequently involved relating to real life and generalization. The increase in modeling tasks associated with multiple categories, which are powerful in encouraging mathematical creativity, suggests that middle school mathematics textbooks place significant emphasis on developing students' mathematical creative thinking skills. It is noticeable that there are very few incomplete problems in the open-ended problem category in 8th grade textbooks. The tasks in textbooks are typically designed to provide students with clear instructions and steps, allowing them to reach solutions more efficiently. With incomplete tasks, students are expected to discover problem-specific connections and fill in the blanks. Cognitively, students are encouraged to develop decision-making and analytical thinking skills. However, the absence of these tasks, particularly at the 8th grade level, highlights a deficiency in mathematics textbooks.

Findings Related to the Category of Problem Posing

The problem-posing category is particularly notable due to its lowest percentage. Analyzing the ratios reveals more problem-posing tasks at the 7th-grade level. Among the textbook types of problem-posing, the free problem-posing category has the fewest tasks. Out of the 1,600 tasks analyzed, only 15 were identified as problem-posing tasks, of which merely one was classified as a free problem-posing type (see Appendix 1). In 2018, the MMC identified problem posing as an essential process skill, highlighting its significance. While it is part of the curriculum, its infrequent coverage in textbooks limits students' opportunities to engage in tasks that foster mathematical creativity.

Findings Related to the Category of Connections

According to the results of the analysis of the category of connection (because it has the highest percentage among all categories), it is the category type with the highest number of tasks that encourage mathematical creativity at each grade level and in both curricula. At the 7th-grade level, the average percentage of tasks related to the connection category is 29.75% in mathematics textbooks prepared according to the 2013 MMC and 35.75% in mathematics textbooks prepared according to the 2018 MMC. The average for grade 8 mathematics textbooks is 25.75% for textbooks prepared according to the 2013 MMC and 37.25% for textbooks prepared according to the 2018 MMC. At both grade levels, it was found that the number of tasks related to the connection category increased from 2013 to 2018 (Figure 5).

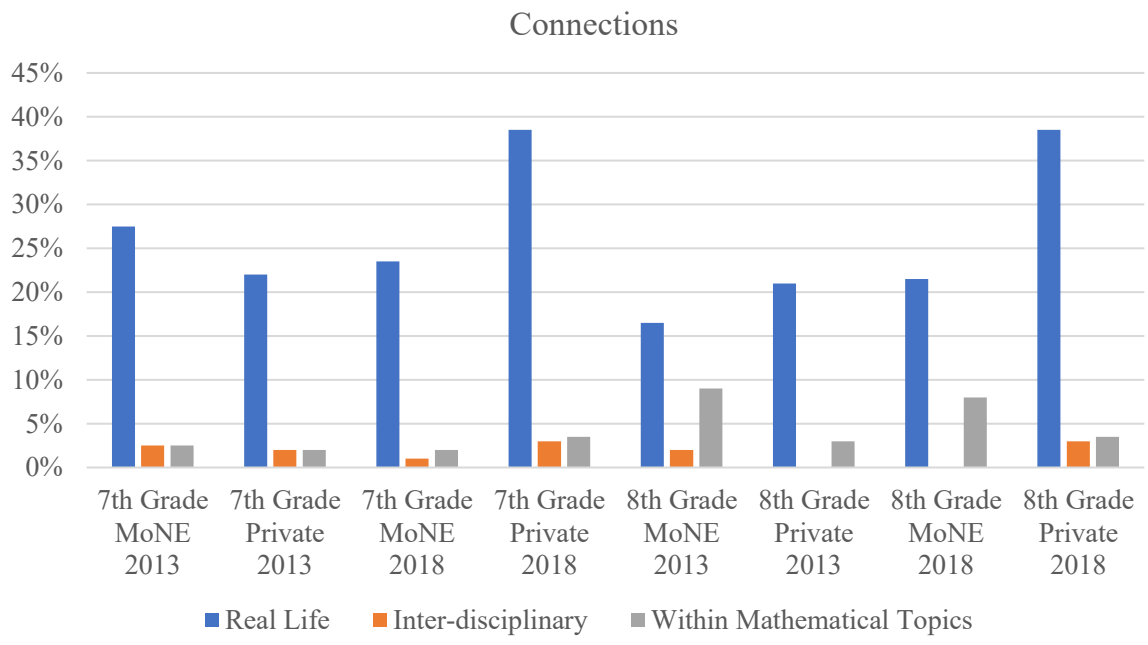


Figure 5 Percentage Rates of the Tasks of the Connections Category in the Textbooks

Findings Related to the Visualization Category

The number of tasks in this category decreased in both grade levels between 2013 and 2018 (see Figure 6). Tasks requiring visualization are more common in 8th grade mathematics textbooks than in other grades. While tasks related to technology integration increase in both 7th and 8th grade textbooks published by the MoNE, the situation reverses in textbooks published by PP.

The number of tasks in the subcategory hands-on manipulatives or materials decreased in both grade levels and publishers. A similar situation was found for the number of tasks related to the other category drawings. Figure 6 shows that the number of tasks requiring drawing for solutions has decreased in all textbooks except for the MoNE publications for 8th grade.

Moreover, the subcategory of this category with the highest number of tasks belongs to the drawing category in 8th grade mathematics textbooks prepared according to the 2013 MMC, with an average percentage of 13.5% (in MoNE and PP textbooks).

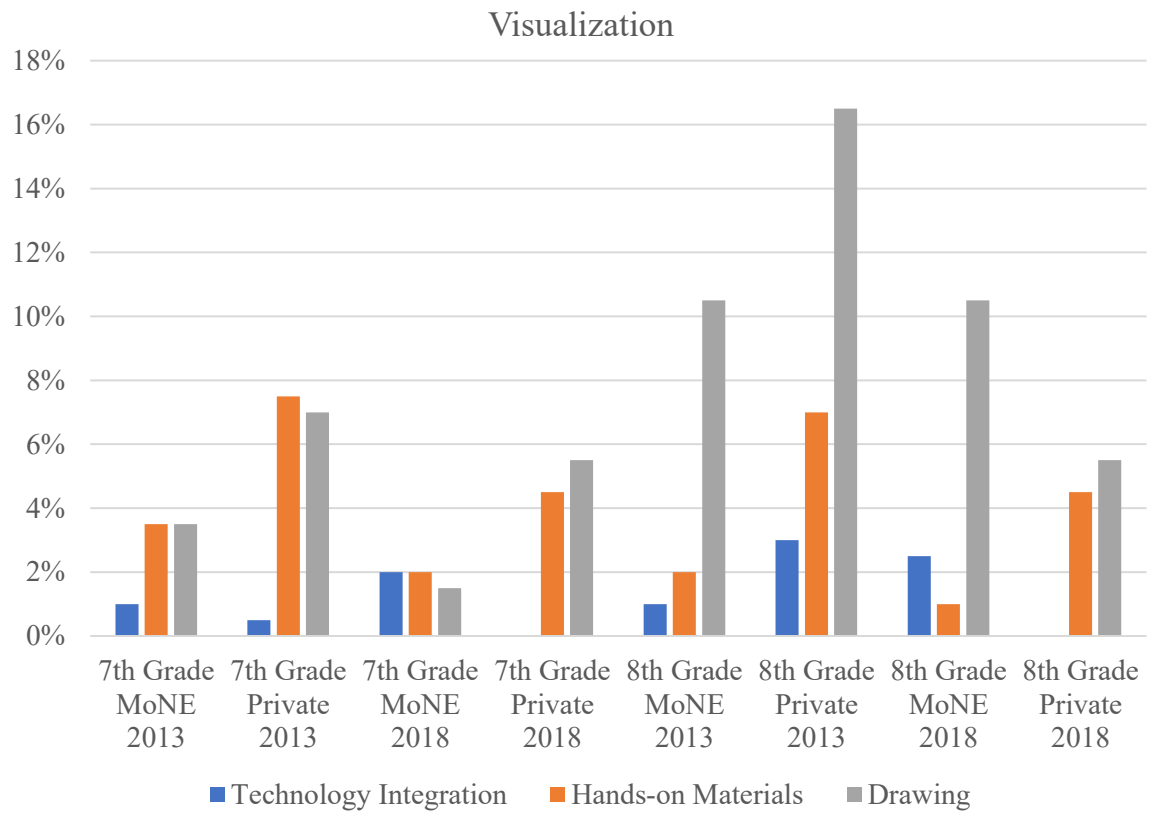


Figure 6 Percentages of the Tasks of the Visualization Category in the Textbooks

Findings Related to the Extensions Category

The subcategories of the extensions category are tasks involving challenging problems, generalization, and justification. In the extension category, the subcategory with the highest proportion of tasks -52% in the main category- found in textbooks aligned with the 2013 MMC was justification. In contrast, for the 2018 MMC, it was generalization, with only a slight difference. The number of tasks with challenging problems in both curricula is limited (see Figure 7).

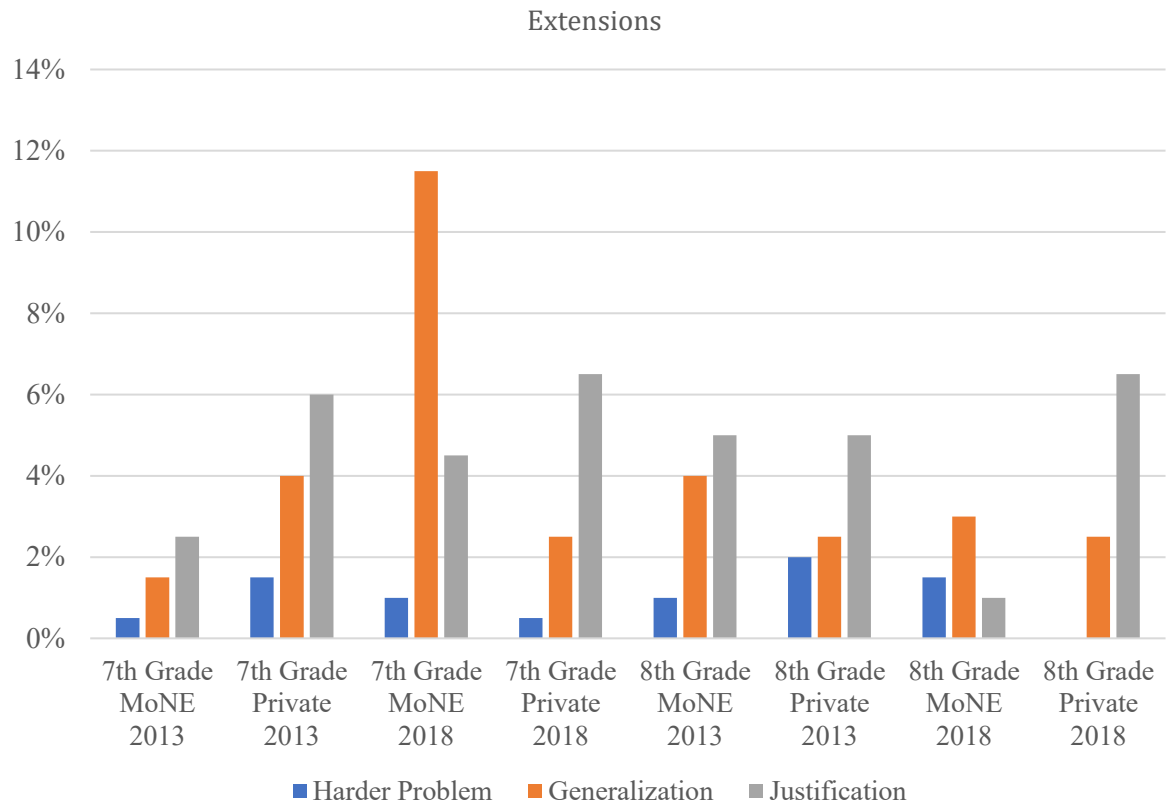


Figure 7 Percentages of the Tasks of the Extensions Category in the Textbooks

Findings Related to the Communication Category

Tasks belonging to the communication category are more frequent in the 7th-grade textbooks than in the 8th grade textbooks. At the 7th grade level, the average number of tasks in the textbooks of the two curricula is a total of 18%, while at grade 8, it is 11%. On the other hand, according to the change between years (from 2013 to 2018), it is observed that there is a decrease in 7th-grade mathematics textbooks and an increase in 8th grade mathematics textbooks (see Figure 8).

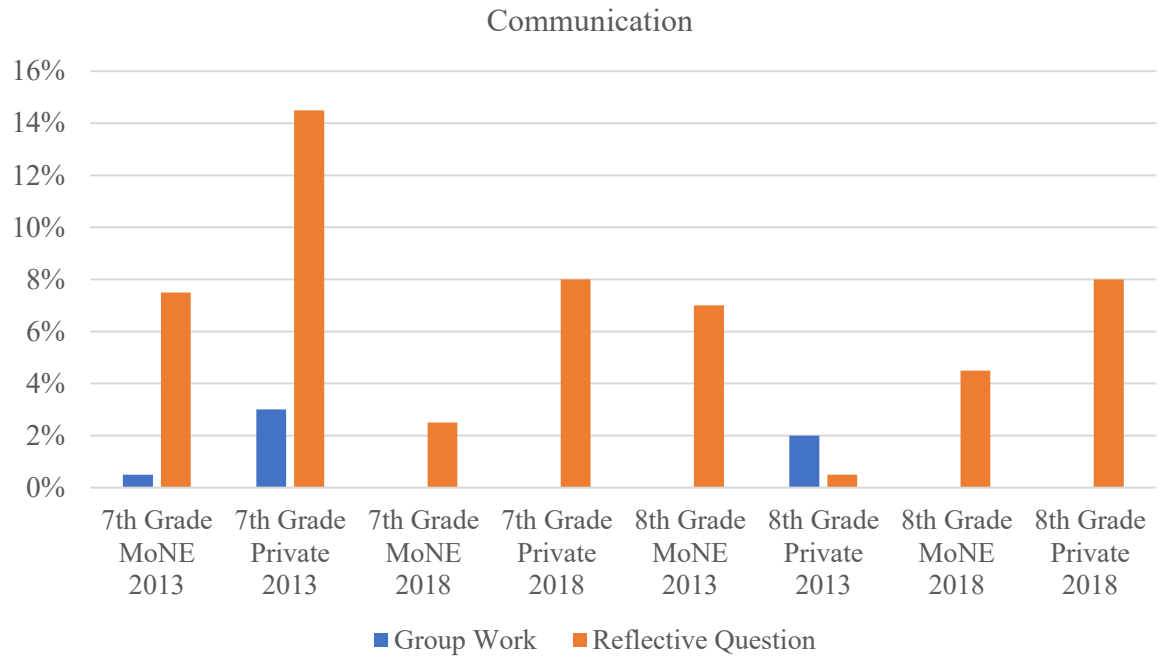


Figure 8 Percentages of the Tasks of the Communication Category in the Textbooks

Findings Related to the Relationship Between Learning Areas and Categories

In this study, the selection of tasks was based on the percentage of course hours assigned to learning areas in the curriculum. If we look at the distribution of tasks that promote mathematical creativity according to learning areas, we see that the highest percentage belongs to the data processing learning area. When we analyze the distribution of tasks that promote mathematical creativity across learning areas, we observe that the numbers and operations learning area has a high 57.8% task distribution rate (2013 MoNE), and the geometry and measurement learning area has an even higher 64.3% rate (2013 MMC-PP). The algebra learning area also has a substantial 72.4% rate (2013 curriculum 8th grade PP), and the data processing learning area has a full 100% rate (2018 curriculum 7th and 8th grade PP).

Results and Discussion

The need for creativity to be included more in curricula and, therefore, in classroom environments has led to the renewal of curricula in many countries (Ahn & Ohn, 2024). This study examined the potential of the tasks in the textbooks aligned with the middle school mathematics curricula implemented in Türkiye in 2013 and 2018 to promote mathematical creativity. The findings indicate that some different dimensions of creativity-directed tasks increased in the transition from the 2013 MMC to the 2018 MMC, while others decreased.

In 7th-grade mathematics textbooks, while the number of open-ended problem tasks remained constant, the number of extension and connection tasks increased, whereas the average number of tasks in the categories of problem posing, communication, and visualization decreased. In Grade 8 textbooks, from 2013 to 2018, there is an increase in the number of tasks that promote mathematical creativity in the categories of communication, connection, and open-ended problems and a decrease in the categories of extensions, visualization, and problem posing. There is an increase in the category of making connections at both grade levels. According to the findings, the reason for the increase in this category is that there are more problems related to real life in the textbooks.

The data regarding the proportions of tasks categorized as open-ended problems indicate that while textbooks do include problems with multiple solutions, some researchers (Levenson, 2022; Leikin, 2009) argue that this category—which holds significant potential for fostering mathematical creativity—is not adequately represented. On the other hand, the modeling subcategory is the category with the highest percentage in this category, while the subcategory with the fewest items is incomplete problems. The tasks in this category are very limited or even non-existent. The prevalence of open-ended problems at the 8th grade level is consistent with Leikin's (2009) observation that multiple solution strategies are more visible at higher grade levels. The prevalence of open-ended problems at the 8th grade level is consistent with Leikin's (2009) observation that multiple solution strategies are more visible at higher grade levels. In general, we can say that despite the importance of the category of open-ended problems in promoting mathematical creativity, which has been emphasized by researchers (Nadjafikhah et al., 2012), we do not see this tendency in textbooks.

Tasks involving problem posing stand out as they have the lowest percentage of all categories. In particular, no tasks involving problem posing were found in the 2018 mathematics textbooks. A similar situation is observed in the study of Bicer et al. (2021). The fact that similar results are obtained from the conceptual framework used in this study shows that the tasks related to problem posing in national and international textbooks are ignored in textbooks. Although the studies revealing the relationship between problem posing and mathematical creativity in the relevant literature are still insufficient (Joklitschke et al., 2019), Cankoy and Darbaz (2010) concluded that problem-posing activities are effective in solution strategies such as expressing problems in different ways, visualizing and creating appropriate models to enhance students' problem-solving abilities and can also significantly improve students' understanding of problems.

When analyzing the results of the connection category, the category in which the tasks in the textbooks are most intensive is the real-life category. Of the 1600 tasks analyzed, 822 belong to this category. This result can be related to the strong emphasis on linking mathematics with daily life in the 2013 and 2018 MMC. On the other hand, it can be seen that the interdisciplinary connection in the textbooks is quite insufficient. It can be said that the results of related studies are in parallel with the results of this study (e.g., Ünal, 2023). Technology integration has the lowest number of tasks in the visualization category. Although there was an increase from 2013 to 2018, it was limited compared to other subcategories promoting mathematical creativity. Considering the schools of the future, especially in mathematics, science, and technology, the inclusion of models that use technology as a key to learning is one of the most important goals that students should achieve (Adams & Hamm, 2010). Although the 2018 MMC placed greater emphasis on technology integration than the 2023 MMC, findings related to the 2018 MMC indicate that this emphasis is not adequately reflected in textbook tasks. Consistent with this, Sevimli and Kul (2015) stated that textbook tasks are mostly inappropriate in terms of technology and focus only on calculator use. The lack of textbooks and similar materials that support technology use is one of the most significant barriers to teachers using technology in classroom activities (İnce-Muslu & Erduran, 2020). Therefore, the development of materials that incorporate technology integration and serve as guidance resources for teachers is crucial for fostering mathematical creativity in students.

Group work and reflective questions in the communication category are closely related to tasks encouraging students to work together. The results show that there is almost no place for group work in the textbooks prepared according to the 2013 and 2018 MMC. It is important to remember that in a learning environment formed by collaborative groups, students can explain how to deal with difficult and complex problems with their own strategies and solution experiences (Flores et al., 2018). Reflective questioning, the ability to produce original answers while solving problems, and group work that helps students understand each other's thought processes and generate alternative solutions are all learning processes that directly influence mathematical creativity (Silver, 1997; Leikin, 2009). It is evident that the emphasis on reflective questions and group tasks in the literature and teaching programs is not fully implemented in practice. It is apparent that creative thinking, which is emphasized in the curricula, is not adequately represented in the mathematics textbooks for 7th and 8th grades, prepared according to the 2013 and 2018 curricula.

Mathematics textbooks prepared according to the 2018 MMC include more tasks that promote mathematical creativity. The likely reason for this outcome is the alteration in the high school entrance exam in Türkiye that took place in 2018. Since that time, the exam has included non-routine mathematics problems that necessitate not only procedural knowledge but also the ability to transform between representations, comprehend reading materials, and employ various strategies. Consequently, this shift has influenced the tasks presented in middle school textbooks. However, to contribute to the development of mathematical creativity, it is important that the tasks belonging to all learning areas encourage mathematical creativity in a balanced way. Furthermore, incorporating multiple dimensions of mathematical creativity within a given task will likely enhance the outcomes' overall quality.

The failure to develop the creative thinking skills targeted in the curriculum through tasks in textbooks may hinder the realization of the intended teaching process in practice. A similar result emerged in the analysis of high school textbooks by Guohua et al. (2025), which revealed that the creative thinking objective included in the curricula of three different countries was not adequately represented in textbooks. Therefore, it can be said that this problem points to a universal issue. In this regard, following universal studies and the evaluations included in these studies appear to be important in the decisions and measures that can be taken.

Recommendations

The main limitation of this study is its focus on textbooks for seventh and eighth grades. It would be advantageous to analyze textbooks spanning from primary to high school to gain a more comprehensive understanding of how school textbooks foster mathematical creativity. Examining the textbooks prepared for the 2024 MMC, which will be gradually implemented at all grade levels over the four years, will make the results acquired from this study even more meaningful. This study proposes that creating guidance resources for teachers—who are the primary practitioners in the classroom—aligned with categories that foster mathematical creativity (specifically problem posing, communication, and technology integration) will enhance the learning and teaching process. These categories were identified as being underrepresented and addressing them can provide vital support for educators.

Compliance with Ethical Standards

Disclosure of potential conflicts of interest

No conflict of interest.

Funding

This article is based on the first author's master's thesis, which was supervised by the second author. The study was completed with the support of a TÜBİTAK scholarship awarded to the first author as part of the 2210-A programme.

CRediT author statement

The researchers took full responsibility for the research.

Research involving human participants and/or animals

This study used document analysis and did not involve human or animal participants.

Ortaokul Matematik Ders Kitaplarının Matematiksel Yaratıcılık Bağlamında İncelenmesi

Özet:

Son yıllarda eğitimciler, matematiksel yaratıcılığı teşvik etmenin önemini giderek daha fazla vurgulamaktadır. Matematiksel yaratıcılık bireylerin kendi öğrenmelerinin sorumluluğunu üstlenmelerini, hızla değişen küresel ortama uyum sağlamalarını ve yenilikçi düşünme becerileri geliştirmelerini sağlamak için çok önemlidir. Bu bağlamda yaratıcılık son yıllarda geliştirilen öğretim programlarının önemli bir bileşeni olmuştur. Buna paralel olarak bu programlar için hazırlanan ders kitaplarının öğrencilerin matematiksel yaratıcılığını desteklemesi ve geliştirmesi beklenmektedir. Bu çalışma, 2013 ve 2018 Ortaokul Matematik Öğretim Programlarına uygun olarak hazırlanan 7. ve 8. sınıf matematik ders kitaplarındaki görevlerin matematiksel yaratıcılığı teşvik etme potansiyellerini tespit etmeyi amaçlamıştır. Milli Eğitim Bakanlığı ve özel yayınevleri tarafından her iki öğretim programına uygun olarak üretilen 7. ve 8. sınıflar için sekiz ders kitabı incelenmiştir. Ders kitaplarındaki görevleri (problemler, etkinlikler ve örnek sorular dahil) değerlendirmek için doküman analizi kullanılmıştır. Sonuç olarak 2018 Ortaokul Matematik Öğretim Programlarına göre hazırlanan ders kitaplarının matematiksel yaratıcılığı teşvik etme açısından daha etkili olduğu tespit edilmiştir. Bu çalışma, ders kitaplarında matematiksel yaratıcılığın hangi bileşenlerinin vurgulandığını ve hangilerinin iyileştirilmesi gerektiğini ortaya koymuştur. Çalışmanın sonuçları eğitimciler ve ders kitabı yazarları için faydalı olacağı düşünülmektedir. Ayrıca, öğretim programı geliştirme ekiplerine değerli bilgiler sağlayarak öğretim tasarımını ve program etkinliğini iyileştirebilir.

Anahtar kelimeler: Matematiksel yaratıcılık, öğretim program, ders kitabı, doküman analizi.

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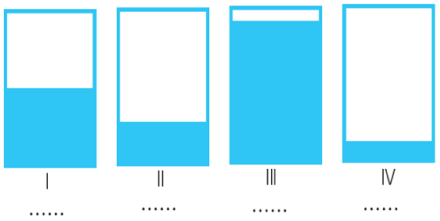
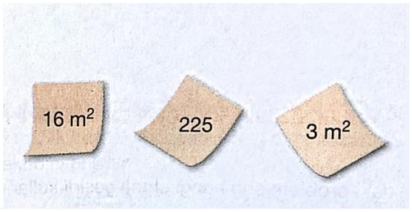
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Appendix 1

Main Categories	Subcategories	Textbooks	Sample Tasks from Textbooks Related Category
Open-Ended Problems	Multiple Solution Paths	*MoNE 2018 / 7th Grade*	In a white goods store, some products have been discounted. The discounted products in the store, their prices before the discount and the discount rates are given in the table on the side. How much does Mr. Emir, who buys a refrigerator, a television and an oven from the store, pay after the discount? **Table:** Discounts on products Product Name / Pre-Discount Price (TL) / Discount Rate (%) Freezer / 3000 / 40 Television / 2000 / 25 Oven / 800 / 10
	More than One Correct Answer	*MoNE 2018 / 7th Grade*	 Let's estimate the approximate values of the amounts of water in the adjacent identical containers as percentages (%).
Problem Posing	Structured	*MoNE 2013 / 7th Grade*	Set up an inverse proportion problem using the data "16 square meters, 225 and 3 square meters". 
	Semi- Structured	*MoNE 2013 / 7th Grade*	Pose a problem using the data "30 minutes, 3 days, 30 minutes".
	Free	*PP 2013 / 7th Grade*	Pose a problem about the orbits of satellites launched into space. Solve the problem you posed by following the problem-solving steps.

Modelling — *MoNE 2018 / 7th Grade*



Let's fill in the table below by analysing the shape pattern formed with matchsticks. Let us state the relationship between the number of matchsticks used and the number of steps as an algebraic expression.

Number of Steps	Number of Matchsticks Used	Relationship Between the Number of Steps and the Number of Matchsticks
1	2	1.2
2	4	2.2
3		
4		
....		
n		

Incomplete Problems — *PP 2013 / 7th Grade*

Fill in the dotted lines in the problem below as appropriate for the problem. Problem: Aslı, an athletics athlete, runs... times the distance she ran the previous day every day according to her training program. She completes her training program by running the distance she is supposed to run on ..... days. If Aslı ran .... km on ... days, how many kilometers did she run on the ... day she completed her training?

Connection

Real Life — *MoNE 2018 / 7th Grade*

While the air temperature in Aydin was +2 degrees, the temperature increased by 5 degrees towards noon. Accordingly, let's find out what the air temperature was at noon.

Inter- disciplinary — *MoNE 2018 / 7th Grade*

Table: Mass And Volume Values of The Silver Element

Mass (g)	31,5	42	73,5	105
Volume (mL)	3	4	7	10

The masses of the silver element in certain volumes are given in the table. Let's interpret these ratios by comparing the masses to their volumes.

Within Mathematical Topics — *MoNE 2018 / 8th Grade*

The area of the ABCD rectangle given above is $14\sqrt{48}$ square centimetres. If the short side length is $2\sqrt{3}$ cm, let's find the long side length.



Technology Integration — *MoNE 2018 / 8th Grade*

Let's Do It Together

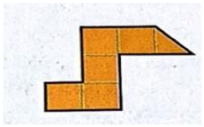
Let's draw equilateral and dichotomous triangles using a computer programme with dynamic geometry software.

Hands-on Materials

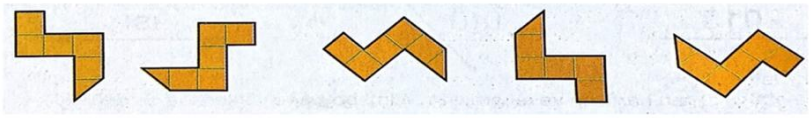
MoNE 2013 / 7th Grade

Activity: Where Does the Figure Turn?

Tools and Equipment: Cardboard, scissors, squared paper, crayons



1) Draw the shape given on the side on a square paper.
   - Cut out the shape with scissors.
2) Put the shape you have obtained on your row and rotate it so that you get the following images.

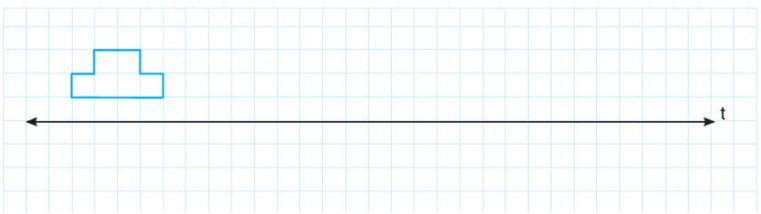


3) Does the shape and size of the rotated shape change? Explain.
   - Does the posture and position of the rotated shape change? Explain.

Drawing

MoNE 2018 / 8th Grade

Draw the images of the polygon below as a result of being first translated 8 units to the right and then reflected with respect to the line t.



Challenging Problem

MoNE 2018 / 8th Grade

Let's Research and Think

Let's investigate and think about the relationship between Pascal's triangle and probability calculation.

Extensions

Generalizations

MoNE 2018 / 7th Grade

ACTIVITY

Tools and Equipment: pot or jar lids, various cylindrical boxes, tape measure, pencil

Implementation Steps:

- Divide into groups of four.
- Measure the circumference of the boxes or lids you have brought with a tape measure.
- Measure the diameters of the surfaces by holding the tape measure so that it passes through the centre of the box and lid surfaces.
- Write your measurements in the table below.

Table: Circumference-diameter relationship of the circle

Relationship Between the Circumference and Diameter of a Circle			
Student	Circumference of the Circle (cm)	Length of the Diameter (cm)	$\frac{\text{Circumference}}{\text{Diameter}}$

- Fill in the last column by making the required calculations.
- What is the relationship between the circumference and diameter of circles?
- How can you generalise from this relationship?

Justification	*MoNE 2018 / 7th Grade*	**Table:** Number of Exports and Imports by Years **Years** / **Export (million)** / **İmport (million)** 2011 / 15 / 10 2012 / 16 / 8 2013 / 16 / 12 2014 / 11 / 13 2015 / 15 / 15 In the table on the right, import and export data of a country by years are given. Which type of graph would be more appropriate to show these data? Draw the graph and explain the reasons.
Communication **Group work / Collabration**	*MoNE 2018 / 7th Grade*	**ACTIVITY** **Tools and Equipment:** parallelogram, rectangle, square, rhombus, trapezoid, different coloured papers, protractor, ruler **Implementation Steps:** • Form groups of 3-4 people. • Take one of the coloured papers in the shape of rectangle, square, parallelogram, trapezoid, rhombus prepared in advance. Name the corners of each quadrilateral as A, B, C, D. • Measure the angles at the corners of these geometric shapes with a protractor. • Write the angles you find in the table below.

	Measure of Angle A	Measure of Angle B	Measure of Angle C	Measure of Angle D	Wholes Angles
Square					
Rectangle					
Trapezoid					
Rhombus					
Parallelogram					