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Pre-service teachers' assessments of the cognitive demand levels and pedagogical compliance of textbook activities

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ABSTRACT

This study aimed to evaluate cognitive demand level and compliance with pedagogical criteria of activities included in the official 5th grade mathematics textbooks. In this context, the last three official 5th grade mathematics textbooks published by the national publisher in Türkiye were examined. A research group consisting of 18 third-year pre-service mathematics teachers was formed, and the participants received the necessary training before the analysis. The study employed a document analysis design and was carried out over a 14-week period. Descriptive and content analyses were applied to the qualitative data, while descriptive and inferential statistics were used to analyze the quantitative data. The results revealed that the number of activities in the textbooks has increased over time; however, their distribution across units was not balanced. Approximately half of the activities were found to be at lower levels of cognitive demand, and several pedagogical criteria were not adequately met. Moreover, the findings indicated a fluctuating pattern in the textbooks' features across the examined years. Based on these findings, several recommendations were proposed for the development of future mathematics textbooks.

Keywords: mathematics textbooks, mathematical activities, cognitive demand levels, pedagogical criteria

INTRODUCTION

Mathematics instruction in schools is largely influenced by textbooks, which reflect the curriculum and the components within the textbook content. All mathematical activities carried out in class form the foundation of student learning (Doyle, 1988). Among these, activities which represent a central concept of the curriculum (Uğurel & Bukova-Güzel, 2010) are incorporated into textbooks as planned and structured elements of the teaching process. The teaching activities included in textbooks are carefully designed and controlled to support learning and are aligned with the course's learning outcomes (Bransford et al., 2000; MacDonald, 2008). Moreover, they facilitate students' comprehension of the topics and promote active engagement in the learning process (Doyle, 1988; Stein & Smith, 1998).

Textbooks establish a connection between the objectives of the curriculum and classroom practice and serve as a primary resource for the mathematics topics to be taught (Haggarty & Pepin, 2002). Activities occupy a central role within the defined objectives. An activity should not be regarded merely as a set of tasks or problem-solving exercises. Activities are not only a reflection of the curriculum's objectives but also serve as fundamental tools integrated with teachers' pedagogical knowledge (Bozkurt, 2018). In other words, activities function as a pedagogical bridge between the teacher, the student, and mathematics (Doyle, 1983). Teachers plan their lessons by following the topics, problems, activities, and pedagogical approaches provided in textbooks (Eisenmann & Even, 2011; Pepin & Haggarty, 2001). In this regard, the pedagogical features, content organization, and instructional objectives of a textbook directly influence the classroom teacher's pedagogical decisions and shape the entire teaching process (Fan & Kaeley, 2000; Zeynivandnezhad et al., 2024). Supporting this view, Kodliuk et al. (2021) emphasize that the didactic structure of textbooks facilitates the learning process through activities. Therefore, it can be concluded that all structural and pedagogical features of a textbook directly affect the quality of its activities.

In the literature, researchers have identified several key characteristics that effective activities should possess. These include being interesting, arousing curiosity, encouraging active student participation, allowing for group work, enabling the use of tools or resources, supporting the use of models, fostering creativity, requiring logical reasoning. In addition, they should involve abstraction, promote higher-order thinking, incorporate real-life situations, appeal to multiple senses, facilitate teaching, be compatible with learning styles and lead to a tangible product at the end of the process, among others (Baki, 2008; Bukova-Güzel

& Alkan, 2005; Doyle, 1988; Olkun & Toluk-Uçar, 2006; Özgen & Alkan, 2012; Özmantar et al., 2010; Toprak et al., 2017; Uğurel et al., 2010).

Students must engage in a series of cognitive processes to achieve success in mathematics activities (Karakuzu, 2017). The cognitive processes expected of students vary according to the cognitive demand levels of the tasks, activities, and other instructional elements found in textbooks. The nature of mathematical tasks can significantly influence students' perspectives on the subject. Cognitive demand level serves as the primary measure for evaluating the cognitive complexity of teaching activities. Stein et al. (2000) define cognitive demand level as the type and degree of thinking required for students to successfully complete instructional activities.

Cognitive demand levels are fundamentally divided into two categories: low cognitive demand level and high cognitive demand level. Low cognitive demand includes memorization and disconnected procedures, whereas high cognitive demand comprises connected procedures and mathematical doing activities (Doyle, 1983). At the rote memorization level, solutions are expected to be obtained by recalling memorized formulas or rules without considering the underlying meaning of the activity. The disconnected procedure involves performing algorithmic operations without requiring students to understand the relationships between concepts (Agterberg et al., 2022; Smith & Stein, 1998; Stein & Lane, 1996). At higher cognitive demand levels, activities are structurally more complex, and students are expected to engage in more meaningful thinking. Connected procedures involve reasoning about relationships between mathematical concepts, incorporating multiple representations, and establishing connections among representations (Agterberg et al., 2022). At the mathematical doing level, students are expected to comprehend and explore the nature of mathematics. This level involves complex and creative forms of thinking that extend beyond algorithmic operations (Boston & Smith, 2009).

Numerous studies examining the activities included in mathematics textbooks from various perspectives have been reported in the literature (Agaç et al., 2023; Bozkurt, 2018; Bozkurt & Yılmaz, 2020; Collopy, 2003; Engin & Sezer, 2016; Ev Çimen & Yıldız, 2017; Jones & Tarr, 2007; Kerpiç & Bozkurt, 2013; Kılıçoğlu, 2020). Some of these studies focus on the content, structural, or pedagogical characteristics of the activities (Agaç et al., 2023; Karama, 2022; Özbey & Özmantar, 2024; Tartan & Erşen, 2024; Tüysüz & Ekici, 2022; Wijaya et al., 2015), whereas others examine the cognitive demand levels of the activities (Bozkurt & Kuran, 2016; Doğdu, 2025; Reçber & Sezer, 2018). When examining the activities in Ministry of National Education (MEB) mathematics textbooks, Reçber and Sezer (2018) compared the cognitive demand levels of the activities in the 8th grade curriculum with those in the textbooks. Their results indicate that textbook activities may exhibit lower cognitive demand than the official curriculum. Bozkurt and Yılmaz (2020) analyzed 8th grade mathematics textbooks and found differences in cognitive demand levels between the two texts. Similarly, Horzum and Duran (2024) investigated the cognitive demand levels of the activities in mathematics textbooks recommended by the MEB for the 2023-2024 academic year. Their findings showed that most tasks were at the memorization and disconnected procedure levels. Likewise, Doğdu (2025) analyzed the cognitive demand levels of tasks in 5th grade mathematics textbooks designed according to the 2018 and 2024 curricula. His study revealed that the 2024 textbook contained fewer activities focused on memorization and disconnected procedures and included more activities that required doing mathematics and establishing connections.

The level of difficulty, the structure of an activity, its content, and its alignment with teaching objectives can influence how students perceive mathematics (Watson & Ohtani, 2015). Therefore, textbooks should include well-designed activities that support the development of students' mathematical reasoning and promote active engagement. Examining the cognitive demand and pedagogical quality of textbook tasks is thus essential. In this context, this study investigates the level of cognitive demand of tasks and their alignment with pedagogical criteria, considering that the clarity of instructions may also play a role. This study was designed with these considerations in mind and aims to contribute to the existing literature. Additionally, it may provide guidance for teachers and publishers in designing more effective activities in future textbooks. To date, no study has been found that evaluates the pedagogical and cognitive characteristics of textbook activities across the last three consecutive editions. Furthermore, the literature review revealed that few textbook evaluation studies involve systematically trained research groups. Most previous research relies primarily on teacher opinions rather than research group assessments (Arslan & Özpınar, 2009; Güder & Tutak, 2012; Kaya-Azar, 2010; Liu et al., 2025; Nemrawi et al., 2022; Özcan & Erduran, 2016). In this regard, the subject and methodology of this study are considered original, distinguishing it from existing research. Moreover, the data collection tool developed in this study for evaluating the pedagogical quality of activities contributes to a novel measurement instrument to the field. The survey items were carefully designed to address an existing gap in the literature, and it is expected that this instrument will serve as a valuable tool for future studies.

In almost all countries, curricula are closely monitored and influenced by educational developments and reforms in other nations, particularly due to advances in technology and information exchange (Schmidt et al., 1996; Valverde et al., 2002). Educational systems in high-performing countries often serve as benchmarks for others, and effective pedagogical approaches are increasingly being adapted across national curricula (Pepin et al., 2013). Textbooks, as the primary instructional materials, are expected to best reflect the philosophy and objectives of a curriculum (Fan et al., 2013; Johansson, 2003). Hence, both curricula and textbooks cannot be considered in isolation from the global educational context. In this sense, the design and structure of recent textbooks can be seen as reflecting broader international trends in mathematics education.

Accordingly, the general purpose of this study is to evaluate the activities in 5th grade mathematics textbooks in terms of their cognitive demand levels and alignment with pedagogical criteria. For this purpose, the most recent three official 5th grade mathematics textbooks used in Türkiye were analyzed by a research group trained specifically for this study. Considering that Türkiye's unique position bridging both Asia and Europe, this research may offer insights not only into the Turkish context but also into global textbook design practices. Within the scope of the research objectives, the following research questions were addressed according to the research group:

1. What is the distribution of activities in the textbooks according to units or themes?
2. What are the cognitive demand levels of the activities in the textbooks?
3. To what extent do the activities in the textbooks align with pedagogical criteria?

METHOD

Research Design

The study examined the most recent 5th grade mathematics textbooks used in Türkiye, designed for students around the age of ten. These books officially published by the MEB Publications following the 2024 curriculum change (Albayrak et al., 2024) [MEB 2024], as well as the two preceding editions: the 2023 edition (Korkmaz et al., 2023) [MEB 2023] and the 2019 edition (Cırıtçı et al., 2019) [MEB 2019]. MEB 2019 textbook does not include a section explicitly titled “activities”; however, its introduction indicates that activities are presented under the section “let’s try this.” Accordingly, the study considered the “let’s try this” and “play time” sections as special activities. The sections under the heading “activities” in MEB 2023 and MEB 2024 were examined in detail.

The MEB 2019 and MEB 2023 textbooks each consist of six units. These units are, respectively:

(1) Natural numbers–Operations with natural numbers,
(2) Fractions–Operations with fractions,
(3) Decimal notation–Percentages,
(4) Basic geometric concepts and drawings–Triangles and quadrilaterals,
(5) Data processing–Length and time measurement, and
(6) Area measurement–Geometric shapes.

The MEB 2024 textbook, however, was revised in accordance with the new curriculum, and therefore differs in several aspects from the previous two editions. The MEB 2024 series is published in two volumes, and instead of the term unit, the term theme is used. It consists of seven themes:

(1) Geometric shapes,
(2) Numbers and quantities–Natural numbers and operations,
(3) Geometric quantities,
(4) Numbers and quantities–Fractions,
(5) Statistical research process,
(6) Algebraic thinking with operations, and
(7) From data to probability.

The activities in all textbooks were evaluated according to their cognitive demand levels and their alignment with pedagogical criteria identified in the literature. In this document analysis study, a research group comprising third-year pre-service teachers in the primary school mathematics teaching program was formed to evaluate the activities. The research group received training on the characteristics of effective activities and the concept of cognitive demand levels. Following the training, the group was assessed and confirmed to possess the necessary knowledge and skills. The cognitive demand levels of all examined activities were discussed and determined collaboratively in a classroom setting, under the guidance of the first author.

Although the dataset is based on Turkish textbooks, the study is grounded in the perspective of analytical generalization, aiming to draw implications relevant to broader international textbook design and mathematics education practices. Given Türkiye’s educational positioning between Asian and European traditions, the findings may reflect hybrid pedagogical patterns and thus contribute to the global discourse on textbook quality and instructional design.

Data Collection Tools

Three data collection tools were developed by the authors for this study. The first tool, the cognitive demand level skill form (CDLSF), was designed to assess the research group’s competence regarding cognitive demand levels after training. The other tools were developed to obtain the research group’s evaluations of the textbooks: the cognitive demand levels assessment form for activity (CDLAFA) and the survey on the compliance of activities with pedagogical criteria (SCAPC). Detailed information about each tool is provided below.

CDLSF

This form contains 12 questions, three from each cognitive demand level, designed to evaluate whether the pre-service teachers had acquired sufficient knowledge and skills regarding cognitive demand levels. Pre-service teachers were asked to indicate the cognitive demand level of each task described, choosing from four levels. Examples from the literature and textbooks (Albayrak et al., 2024; Bektaş et al., 2019; Cırıtçı et al., 2019; Korkmaz et al., 2023; Polat, 2021; Smith & Stein, 1998; Stein et al., 2000) were used to construct the form. The opinions of an expert academic were also consulted, and the researchers and expert agreed on the cognitive demand levels of the questions. **Figure 1**, **Figure 2**, **Figure 3**, and **Figure 4** shows the example questions used in the CDLSF regarding cognitive demand levels.

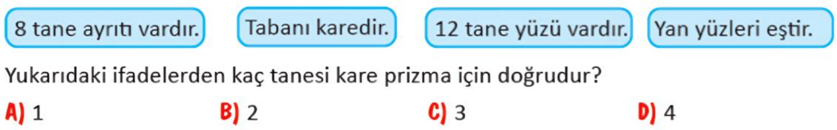


Figure 1. Example of a memorization level question (Korkmaz et al., 2023, p. 308) (original item in Turkish, English translation: There are 8 edges, the base is a square, it has 12 faces, the lateral faces are equal. How many of the above statements are correct for a square prism?)

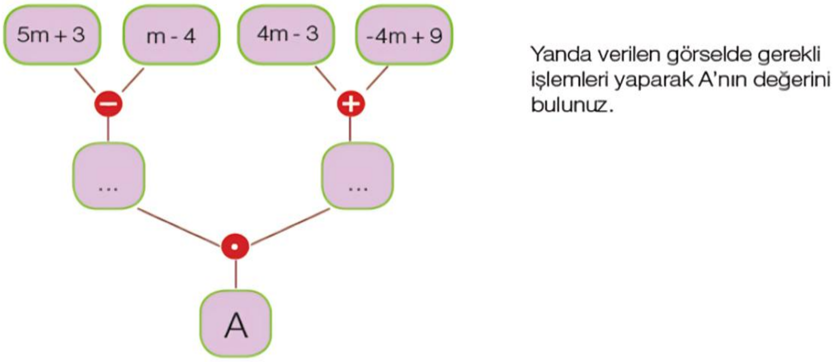


Figure 2. Example of a procedure without connection question (Keskin-Oğan & Öztürk, 2019, p. 137) (original item in Turkish, English translation: Find the value of A by performing the necessary operations in the given figure on the side)

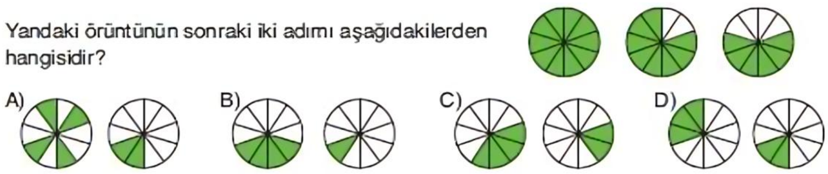


Figure 3. Example of a procedure with connection question (Polat, 2021, p. 85) (original item in Turkish, English translation: Which of the following are the next two steps of the pattern on the side?)

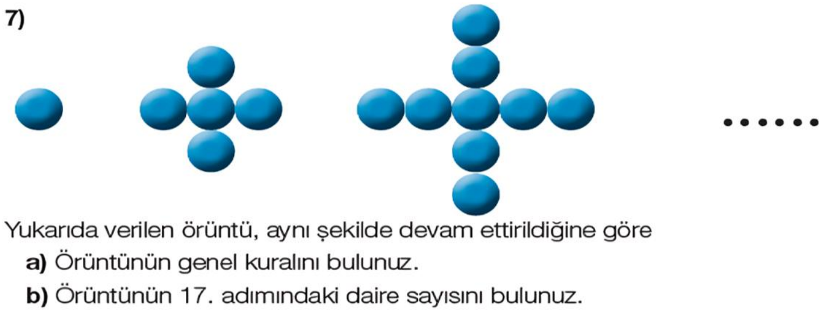
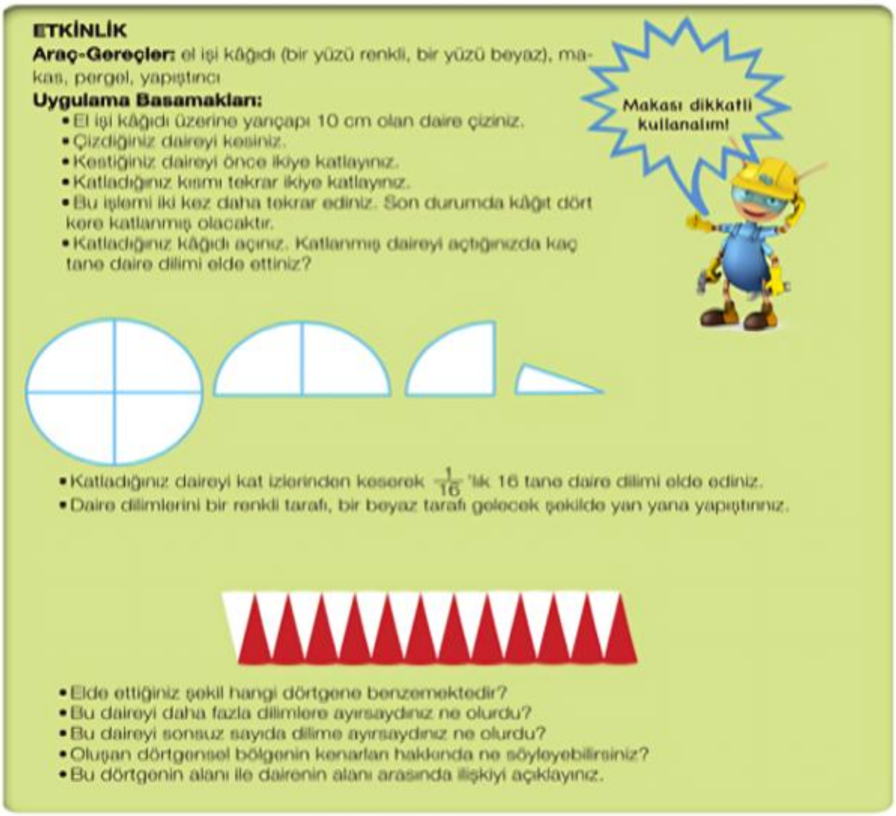


Figure 4. Example of a doing mathematics cognitive demand level question (Keskin-Oğan & Öztürk, 2019, p. 137) (original item in Turkish, English translation: Given that the pattern above continues in the same way: a) Find the general rule of the pattern. b) Find the number of circles in the 17th step of the pattern)

CDLAFA

Developed to evaluate the cognitive demand levels of activities in the textbooks, CDLAFA required pre-service teachers to use Polat's (2021) cognitive demand level analysis framework (CDLAF), previously taught to them. CDLAF is provided in **Appendix A**. The research group indicated the cognitive demand levels using framework codes and provided justifications. CDLAFA also included the activity name, page number, unit/theme, and learning outcome. An example of an evaluation using the form is presented in **Figure 5**.



ETKİNLİK

Araç-Gereçler: el işi kâğıdı (bir yüzü renkli, bir yüzü beyaz), makas, pergel, yapıştırıcı

Uygulama Basamakları:

- El işi kâğıdı üzerine yarıçapı 10 cm olan daire çiziniz.
- Çizdiğiniz daireyi kesiniz.
- Kestiğiniz daireyi önce ikiye katlayınız.
- Katladığınız kısmı tekrar ikiye katlayınız.
- Bu işlemi iki kez daha tekrar ediniz. Son durumda kâğıt dört kere katlanmış olacaktır.
- Katladığınız kâğıdı açınız. Katlanmış daireyi açtığınızda kaç tane daire dilimi elde ettiniz?

Makası dikkatli kullanalım!

- Katladığınız daireyi kat izlerinden keserek $\frac{1}{16}$'lık 16 tane daire dilimi elde ediniz.
- Daire dilimlerini bir renkli tarafı, bir beyaz tarafı gelecek şekilde yan yana yapıştırınız.

- Elde ettiğiniz şekil hangi dörtgene benzemektedir?
- Bu daireyi daha fazla dilimlere ayırsaydınız ne olurdu?
- Bu daireyi sonsuz sayıda dilime ayırsaydınız ne olurdu?
- Oluşan dörtgensel bölgenin kenarları hakkında ne söyleyebilirsiniz?
- Bu dörtgenin alanı ile dairenin alanı arasında ilişkiyi açıklayınız.

Activity name and page number	Activity Page: 239		
Unit	5th Unit		
Related learning outcome	**M.7.3.3.** Calculates the area of a circle and a sector of a circle		
Cognitive demand levels			
	YES	NO	EXPLANATION
Memorization			The activity derives the area formula of a circle from the area of a parallelogram. Additionally, it aims to help students understand the nature of mathematical concepts.
Procedure without Connection			
Procedure with Connection			
Doing mathematics	X		

Figure 5. Example of an activity evaluation using CDLAFA (Source: Authors' own elaboration)

SCAPC

Developed to evaluate the alignment of activities with pedagogical criteria, since no existing measurement tool was found in the literature. The survey was based on 45 items compiled by Öztürk (2016) regarding characteristics that activities should possess. After expert review, two items were removed, reducing the total to 43 items. The final survey was also reviewed by a language expert and included a 5-point Likert scale ranging from "very low" to "very high." The internal consistency coefficient was .96. The SCAPC is provided in **Appendix B**.

Research Group and Training Process

The research group consisted of 18 third-year pre-service mathematics teachers enrolled in the primary mathematics education program at a state university in Türkiye. Criterion sampling was employed to select the participants. The selection criteria included enrollment in the course developing activities in mathematics education, taught by the first author, and possession of sufficient prior knowledge regarding cognitive demand levels. The institution was selected based on accessibility and feasibility considerations. In addition, as the primary mathematics education program is implemented in a standardized manner across Türkiye, it was assumed that the participants would exhibit characteristics representative of pre-service mathematics teachers nationwide. The course content covered the purpose and importance of activities, characteristics of effective activities, considerations for activity preparation and implementation, activity evaluation and development, and assessment in activity-based instruction (Council of Higher Education [YÖK], 2018).

In the teaching of this course, a flipped learning supported performance based instructional approach was implemented. The data for this study were collected during the instructional process of the course. A virtual classroom environment was created for the research group, and weekly course contents were uploaded prior to class sessions to ensure that the research group attended the lessons prepared. In addition, all necessary instructional materials (course presentations, academic resources, curricula, assignments, and textbooks) were provided through the virtual classroom, thereby supporting the learning process. In this respect, the course design aligns with the core principles of the flipped learning approach.

In the flipped learning model, providing access to instructional materials before class enables in-class time to be devoted to deeper instructional activities (Sargent & Casey, 2020). The first phase of the model allows students to engage with course materials prior to class (Fung, 2020; Yu & Gao, 2022), whereas the second phase emphasizes active participation in in-class activities (Sailer & Sailer, 2021). Classroom practices such as discussion, product creation, and problem solving are considered effective activities within the flipped learning framework (Huang et al., 2019; Lo et al., 2017).

The extent to which the research group possessed sufficient knowledge of cognitive demand levels was assessed using a screening test developed by the researchers. The results indicated that the research group achieved at least an 80% success rate, which justified progression to the second phase of instruction, namely performance-based teaching. At this stage, the primary objective was for the research group to apply their theoretical knowledge in practice.

Performance-based instruction is an action-oriented learning approach that emphasizes learners' application of knowledge and skills through authentic tasks connected to real-life contexts. Within this approach, students develop both cognitive and practical competencies by completing tasks that require meeting specific standards. Performance-based learning is characterized by active learner participation, systematic feedback on performance, and meaningful learning experiences that simulate real-life situations (Hibbard et al., 1996). In this model, the instructor assumes the role of a "performance coach," guiding students as they progressively develop their skills. The learning process is structured around activities such as application, production, and problem solving (Jones, 2001). Accordingly, performance-based instruction provides an authentic learning environment that integrates theory with practice and promotes deep and lasting learning.

In the present study, performance-based instruction was implemented to enable the research group, whose theoretical knowledge of cognitive demand levels was deemed sufficient, to apply this knowledge to a concrete context. Within the scope of the study, the research group were assigned tasks requiring them to evaluate activities in mathematics textbooks based on the proposed theoretical framework and to present their evaluations in class. The presentations were conducted sequentially using activities from the MEB mathematics textbooks published in 2024, 2023, and 2019.

The CDLSF was used to measure the research group's knowledge and skills related to cognitive demand levels. **Table 1** presents the performance of the research group. The results indicated an overall success rate of 83%, with the majority of the research group achieving 10 or more correct answers, demonstrating sufficient knowledge and skills for evaluating cognitive demand levels.

Table 1. The research group's achievements obtained from the CDLSF

Number of pre-service teachers	Number of correct answers	Success rate
3	8	66%
2	9	75%
6	10	83%
6	11	91%
1	12	100%
Total	180	83%

Following this assessment, the research group evaluated textbook activities using the CDLAFA and completed the SCAPC individually. Each pre-service teacher generally evaluated activities from one unit, and two pre-service teachers presented their evaluations each week. The evaluations were discussed in class, and the first author participated in these discussions. The evaluations approved by the majority were submitted as assignments via the virtual classroom. **Table 2** summarizes the study plan, including weekly data collection and evaluation procedures.

Table 2. Study plan, detailing weekly data collection and evaluation procedures

Week	Data collection process
Week 1-week 5	• Presentation of course content and uploading relevant materials to the virtual classroom. • Instruction on cognitive demand levels and uploading related presentations. • Introduction of CDLAF and example classifications. • Presentation of textbooks and uploading textbooks and curricula to the virtual classroom. • Introduction to SCAPC and CDLAFA with example assessments. • Administration of the CDLSF and assignment of tasks.
Week 6-week 14	• Presentation of textbook activities and evaluations conducted using CDLAFA and SCAPC. • Classroom discussion of the accuracy of each evaluation. • Revision and submission of final versions of CDLAFA and SCAPC via the virtual classroom.

Figure 6 depicts the examples of presentations made by the research group.

Figure 6. Examples of presentations made by the research group (Source: Authors' own elaboration)

Data Analysis

Data were collected from CDLAFA and SCAPC. Descriptive analysis was applied to qualitative data from CDLAFA, classifying activities by unit/theme and cognitive demand level. Quantitative data from SCAPC were analyzed using descriptive (mean and standard deviation) and inferential (one-way ANOVA and LSD post-hoc test) statistics. SCAPC scores ranged from 43 to 215, and compliance levels were evaluated as: "very low: 1.00-1.80, low: 1.81-2.60, medium: 2.61-3.40, high: 3.41-4.20, very high: 4.21-5.00"

As each pre-service teacher evaluated different sections of the textbooks, it was not possible to calculate inter-rater reliability. The evaluation process was therefore finalized through consensus reached during class discussions involving the first author. In addition, the second author independently classified the cognitive demand levels of the activities. The level of agreement between the evaluations of the research group and those of the second author was calculated as 87%, indicating a high level of consistency.

RESULTS

Distribution of Activities in Textbooks According to Units/Themes and Cognitive Demand Levels

This section presents the findings on the distribution of activities in the textbooks by unit/theme and cognitive demand level, based on evaluations conducted by the research group. First, the distribution of activities according to units/themes was analyzed, and the results are presented in **Table 3**.

Table 3. Distribution of activities in textbooks according to units/themes

Units/themes	MEB 2019	MEB 2023	MEB 2024
Units/themes 1	11	26	8
Units/themes 2	7	15	24
Units/themes 3	9	10	16
Units/themes 4	10	13	29
Units/themes 5	6	9	8
Units/themes 6	7	8	21
Themes 7			7
Total	50	81	113

According to **Table 3**, MEB 2019 contains 50 activities, MEB 2023 contains 81, and MEB 2024 contains 113 activities. The distribution of activities across units in MEB 2019 was relatively balanced. In MEB 2023, the unit on natural numbers and operations had a higher number of activities compared to other units, while the distribution in the other units was similar. In MEB 2024, a similar number of activities were observed in the themes of geometric shapes, algebraic thinking with operations, statistical research process, and fractions, and these themes had a higher proportion of activities compared to the other textbooks. Other themes had a comparable number of activities. Each theme contained a minimum of seven and a maximum of 29 activities. When evaluated in terms of content similarities across units and themes, the number of activities related to numbers and operations, fractions, geometric shapes, and data processing has increased over the years.

After establishing the quantitative increase in activities over time, the qualitative aspect of these activities was examined by analyzing their cognitive demand levels. The results are presented in **Table 4**.

Table 4. Cognitive demand levels of activities in textbooks

Cognitive demand levels	MEB 2019	MEB 2023	MEB 2024	Total
Memorization	2 (%4)	19 (%23)	10 (%9)	31(%13)
Procedure without connection	13 (%26)	54 (%67)	25 (%22)	92 (%38)
Procedure with connection	6 (%12)	7 (%9)	25 (%22)	38 (%15)
Doing mathematics	29 (%58)	1 (%1)	53 (%47)	83 (%34)
Total	50 (%100)	81 (%100)	113 (%100)	244 (%100)

Table 4 shows that most activities in MEB 2019 are at the doing mathematics level, with 12% of activities being procedures with connection. Approximately 26% of activities are at the procedures without connection level, while only 4% are at the memorization level. Overall, 70% of the activities in this textbook require higher-order cognitive demands. In MEB 2023 , most activities (67%) were at the procedures without connection level. Only 10% of the activities were at the procedures with connection or doing mathematics levels, indicating that 90% of the activities were at a lower cognitive demand level. In MEB 2024 , approximately half of the activities were at the doing mathematics level, and 22% were at the procedures with connection level. Activities at the memorization and procedures without connection levels accounted for 9% and 22%, respectively. Thus, 69% of the activities required higher-order cognitive demands, while 31% were at lower levels.

Comparing the textbooks, MEB 2019 had the highest proportion of activities at the doing mathematics level, whereas activities at the procedures with connection level were most prevalent in MEB 2024. Activities at the procedures without connection and memorization levels were most common in MEB 2023. Activities requiring the highest cognitive demand were similarly represented in MEB 2019 and MEB 2024, while those requiring the lowest cognitive demand were most frequent in MEB 2023. Overall, MEB 2019 and MEB 2024 appear to be the most qualified in terms of cognitive demand levels. MEB 2024 stands out due to the high number of activities requiring higher-order cognitive demands, while MEB 2019 is distinguished by its relatively high proportion of such activities. When the total activities in the three textbooks were evaluated, it was found that approximately half of the activities were at a low cognitive demand level.

The Research Group's Evaluation of the Compliance of Activities in Textbooks With Pedagogical Criteria

This section presents the research group's assessment of the alignment of activities included in textbooks with pedagogical criteria. To this end, a total of 244 SCAPC forms, prepared for each activity and evaluated by the research group, were analyzed. Descriptive statistical results regarding the scores obtained from the SCAPC are presented in **Table 5**.

Table 5. Descriptive statistics results of scores obtained from SCAPC

Textbooks	N	Minimum	Maximum	X	ss	Level of compliance
MEB 2019	50	1.56	4.21	3.39	.81	Level 3
MEB 2023	81	1.56	4.07	2.34	.67	Level 2
MEB 2024	113	1.93	4.56	3.09	.53	Level 3

Table 5 shows that the average compliance score of the activities in the MEB 2019 with pedagogical criteria is higher than that of the other textbooks. The lowest average score was found in the activities in the MEB 2023. Considering that the average scores that activities can achieve range from 1 to 5, it was determined that the activities in MEB 2019 and MEB 2024 are above average in terms of compliance with pedagogical criteria, while MEB 2023 activities are below average. Accordingly, it can be said that MEB 2023's alignment with pedagogical criteria is negative, while the activities in the other textbooks are positive.

To provide a more detailed description of the textbooks' alignment with pedagogical criteria, the level of compliance of the textbooks were examined for each criterion. **Table 6** presents information on the pre-service teachers' evaluations regarding the textbooks' alignment with pedagogical criteria.

Table 6. Level of compliance of the activity with the pedagogical criteria

Level of compliance	MEB 2019	MEB 2023	MEB 2024	Total
Very low	0	12	0	12
Low	1	23	10	34
Medium	20	4	26	50
High	20	3	7	30
Very high	2	1	0	3

According to **Table 6**, the MEB 2019 textbook mostly complies with the pedagogical criteria at a moderate to high level. However, it remains relatively weak in terms of appealing to multiple senses. In contrast, the activities demonstrate high compatibility with the criteria of being student-centered and applicable. The activities in the MEB 2024 textbook were found to be moderately aligned with the pedagogical criteria overall. They are highly consistent with the goals (learning outcomes), student level, learning styles, classroom management, and student-centered approaches. However, they were found to be weak in addressing individual differences, multiple senses, collaborative learning, multiple intelligences, offering alternative solutions, cognitive conflict, product creation, and use of materials. The activities in the MEB 2023 textbook were generally assessed as having a low level of alignment. Only the criterion of applicability was found to be highly consistent. Particularly low levels were observed for criteria such as considering prior knowledge, being material-based, addressing multiple intelligences, and appealing to more than one sense.

When these findings are evaluated collectively, it can be stated that pre-service teachers perceived the MEB 2019 textbook as the most consistent with the pedagogical criteria, while the MEB 2023 textbook was viewed as the least consistent. To determine whether this descriptive pattern was statistically significant, a one-way ANOVA test was conducted on the relevant alignment scores. The results obtained from this analysis are presented in **Table 7**.

Table 7. One-way ANOVA test applied to the scores obtained from SCAPC for activities in textbooks

Source of variance	Sum of squares	df	Average of squares	F	p	Significant difference
Between groups	41.636	2	20.818	49.435	.000	MEB 2019 > MEB 2024 > MEB 2023
Within the group	101.490	241	.421			
Total	143.126	243				

The data in **Table 7** indicate that the difference in alignment scores between textbooks was statistically significant ($F [2, 243] = 49.435$, $p < .05$, $\eta^2 = .29$). Accordingly, the research group assessed that the activities in MEB 2019 were more aligned with pedagogical criteria than the others. It was also determined that the activities in MEB 2024 were more consistent than those in MEB 2023. By contrast, MEB 2023 showed the lowest level of alignment with pedagogical criteria. In general, the ranking of meaningful score differences was “MEB 2019 > MEB 2024 > MEB 2023.”

DISCUSSION

This study aimed to evaluate the cognitive demand levels and compliance with pedagogical criteria of activities included in the official 5th grade mathematics textbooks in Türkiye. The results revealed an increase in the number of activities over time, with the MEB 2024 textbook containing the highest number. This finding suggests that classroom activities are now given greater importance in textbooks, reflecting a shift toward more active student engagement and providing teachers with a wider range of instructional tools. The distribution analysis showed that the MEB 2019 textbook presented activities in a balanced manner across units. In contrast, MEB 2023 included a higher concentration of activities on natural numbers and operations, while MEB 2024 emphasized geometric shapes, algebraic thinking, the statistical research process, and fractions. Over the years, the number of activities related to numbers, fractions, geometry, and data processing has increased.

Activities should be designed to support the development of students’ mathematical reasoning and mathematical thinking skills (Henningsen & Stein, 1997). Higher-level cognitive mathematical tasks are considered effective in supporting higher-order thinking skills (Stein et al., 1996). In this regard, the findings revealed clear differences in cognitive demand across textbooks. MEB 2019 contained many activities requiring higher-level cognitive demand, particularly at the “doing mathematics” level. By contrast, MEB 2023 predominantly included lower-level activities, with most falling under “procedures without connections.” MEB 2024 represented an improvement compared to 2023, as it included more activities requiring “procedures with connections” and “doing mathematics.” However, the cognitive demand level in MEB 2024 still does not match the higher levels observed in MEB 2019. Since cognitive demand is a key indicator of instructional quality (Jones & Tarr, 2007), this decline remains a concern.

The results are consistent with prior research. Horzum and Duran (2024) similarly reported lower cognitive demand levels in MEB 2023, while Doğdu (2025) emphasized that textbooks prepared under the 2018 curriculum (e.g., MEB 2019) included more cognitively demanding activities than those prepared under the 2024 curriculum. In line with these findings, the pre-service teachers in this study reported that MEB 2019 and MEB 2024 were more student-centered and contained more higher-level activities than MEB 2023, with MEB 2019 standing out as having the highest cognitive demand overall.

Peled (2007) emphasizes that activity objectives should be developed by considering psychological, epistemological, curricular, and pedagogical dimensions. Regarding pedagogical alignment, the findings indicated that MEB 2019 and MEB 2024 performed above average, whereas MEB 2023 was below average. Statistically significant differences were found among the textbooks, with compliance ranked as MEB 2019 > MEB 2024 > MEB 2023. Specifically, MEB 2019 was strong in discovery-based learning and student-centered approaches. MEB 2024 showed stronger alignment with student level, learning styles, and classroom management, but weaker performance in addressing individual differences, collaborative learning, and multiple intelligences. MEB 2023 performed poorly overall, particularly in criteria such as prerequisite knowledge and sensory engagement.

The findings further revealed that although MEB 2024 was developed within the framework of the Türkiye Century Education Model, the activities did not sufficiently reflect the model’s multidimensional skill framework. The model emphasizes critical thinking, collaboration, curiosity, problem-solving, and adaptability (MEB, 2024). However, the low alignment observed across several of these dimensions suggests that the intended holistic orientation of the framework has not yet been adequately translated into textbook activities.

CONCLUSION

This study demonstrates that although the number of activities in 5th grade mathematics textbooks in Türkiye has increased over time, improvements in quantity have not been accompanied by consistent improvements in cognitive demand and pedagogical quality. While MEB 2024 shows partial recovery compared to MEB 2023 in terms of cognitive rigor and pedagogical alignment, it still falls behind the levels observed in MEB 2019. The results indicate that recent textbook revisions have not fully sustained the level of cognitive challenge and pedagogical richness required to support higher-order mathematical thinking.

Moreover, despite being grounded in the Türkiye century education model, the MEB 2024 textbook does not yet sufficiently reflect the model's emphasis on 21st century skills such as critical thinking, collaboration, and problem-solving. This gap suggests a misalignment between curriculum-level intentions and their operationalization in textbook activities. Overall, the findings highlight the need for greater coherence between curriculum reforms and the design of learning activities in textbooks.

Recommendations

The findings indicate that although the number of activities in textbooks has increased over time, nearly half of these activities remain at low levels of cognitive demand. While a higher number of activities may offer teachers more instructional options, the balance between quantity and cognitive quality should be carefully considered. Given time constraints in classroom practice, future textbooks should prioritize a manageable number of activities that are feasible to implement and that promote higher-order thinking. In particular, a greater number of activities should be designed at the "procedures with connections" and "doing mathematics" levels.

Fluctuations across textbook editions in terms of cognitive demand and pedagogical quality indicate a lack of consistency in textbook design standards. To ensure sustainability and quality assurance, national-level guidelines for the design and evaluation of textbook activities should be established. Regular monitoring of textbook quality based on these standards could help prevent declines in cognitive rigor and pedagogical alignment over time.

Several pedagogical criteria were found to be insufficiently addressed, including attention to individual differences, multisensory learning, collaborative learning, multiple intelligences, alternative solution strategies, cognitive conflict, product creation, prior knowledge, concrete materials, and interdisciplinary connections. Future textbook development processes should systematically integrate these principles to enhance inclusiveness and instructional effectiveness.

Future research may extend this line of inquiry by

(a) including larger and more diverse evaluator groups,

(b) analyzing additional textbook series and grade levels, and

(c) employing mixed-methods designs that integrate document analysis with classroom-based data.

Cross-national comparative studies may also provide valuable insights into similarities and differences in cognitive and pedagogical structures across educational systems. Alternative expert panels could be employed to examine additional textbook characteristics.

Finally, future studies may focus on the instructional dimension of evaluator training. The flipped learning-supported performance-based instruction implemented in this study appeared to support pre-service teachers' understanding and application of cognitive demand levels. This instructional approach can be examined more rigorously through experimental or quasi-experimental designs to determine its effectiveness in evaluator training and teacher education contexts.

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APPENDIX A

Table A1. CDLAF (Polat, 2021)

CDL	Demand codes
Memorization level (low-D): Low-level demand codes	
1.1	Recall of previously learned knowledge, rules, formulas, or definitions
1.2	Use of a method or procedure in the solution process without requiring further reasoning or calculation
1.3	Repetition of previously learned knowledge, rules, formulas, or definitions. Recall and repetition are sufficient, there is no need to make sense of or create knowledge, and there is no ambiguity
1.4	No requirement to connect recalled knowledge, rules, formulas, or definitions with underlying concepts and meanings
Procedures without connections level (low-C): Low-level demand codes	
2.1	Involves algorithmic procedures. The procedure is explicitly stated, or the task requires recalling a previously taught algorithm/procedure and applying it as it is.
2.2	Task can be carried out as a routine without requiring extended cognitive effort
2.3	Very limited ambiguity about how and when the task should be executed
2.4	Requires direct application of definitions and procedures instead of developing or reasoning mathematically, leading to predetermined answers
Procedures with connections level (high-C): High-level demand codes	
3.1	Provides opportunities for deepening and understanding mathematical concepts and ideas
3.2	Emphasizes the importance of mathematical thinking rather than only following general procedures
3.3	Use of multiple representations (diagram, graph, manipulatives, symbols, algebraic, etc.) and establishing relationships among them
3.4	Requires cognitive effort to identify underlying conceptual ideas and causes
Doing mathematics level (high-M): High-level demand codes	
4.1	Involves complex situations that cannot be solved solely with algorithms or explicit instructions, requiring reasoning
4.2	Understanding the nature of mathematical concepts, processes, and their relationships
4.3	Involves self-regulation and self-management
4.4	Using appropriate prior knowledge throughout the problem-solving process (e.g., research or project)
4.5	Analyzing tasks, producing alternative solutions and strategies, and identifying limitations or missing aspects
4.6	Requires significant cognitive effort
4.7	May cause mental struggle or cognitive conflict for students due to the inclusion of methods and pathways not explicitly structured in the solution process

Note. CDL: Cognitive demand leve

APPENDIX B

Table B1. SCAPS

Indicate the level of compliance of the activity with the following criteria	**VL**	**L**	**M**	**H**	**VH**
1. Suitability for purpose					
2. Requiring higher-level thinking					
3. Include real-life situations					
4. Taking students' prior knowledge into account					
5. Being material-based					
6. Being appropriate for the student's level					
7. Allowing students to create models					
8. Being of a nature to arouse curiosity					
9. Increasing motivation					
10. Assisting in the use and development of mathematical language (expressions and symbols)					
11. Delivering a product at the end of the process					
12. Suitability for student and teacher roles					
13. Providing opportunities to make logical inferences through abstraction					
14. Taking into account students' individual differences					
15. Appealing to multiple senses					
16. Enabling on-site and off-site connections					
17. Providing students with the opportunity to demonstrate their thoughts and solutions regarding a situation					
18. Requiring reasoning skills					
19. Ensuring active participation					
20. Not making classroom management difficult					
21. Give students the opportunity for discussion					
22. Facilitating student interactions					
23. Being applicable					
24. Opportunity to communicate					
25. Ensuring collaboration					
26. Suitability for individual learning styles					
27. Being student-centered					
28. Involving mental and physical action					
29. Having more than one starting point					
30. Providing opportunities for lasting and effective learning					
31. Suitability for the physical structure of the classroom					
32. Providing students with the opportunity to engage in self-assessment					
33. Utilizing problem-solving skills					
34. Involving cognitive conflict					
35. Include different solutions					
36. Realizing that mathematics is not discrete but cumulative					
37. Ensuring the use of cognitive processes					
38. Addressing multiple intelligence areas					
39. Include problems appropriate for students					
40. Highlighting critical points related to the concept to be created					
41. Enabling students to structure knowledge					
42. Taking into account student difficulties and misconceptions					
43. Enabling measurement and evaluation throughout the process					
Please state your overall opinion about the event:					

Note. VL: Very low; L: Low; M: Middle; H: High; & VH: Very high