Cakrawala Jurnal Ilmiah Bidang Sains
ISSN: 2964-075X (Print)
ISSN: 2962-7281 (On Line)
Akreditasi Sinta 4 oleh Kemdiktisainteki,SK No: 10/C/C3/DT.05.00/2025
DOI: 10.28989/cakrawala.v1i2.2996

A comparative analysis of Indonesian and Singaporean mathematics textbooks on the topic of polyhedrons

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Article Info

Article history:

Received May 17, 2025
Accepted June 16, 2025
Published June 25, 2025

Keywords:

Mathematics textbook
Polyhedrons
Curriculum

ABSTRACT

This study aims to conduct a comparative analysis of three mathematics textbooks on the topic of Polyhedrons, namely two textbooks from Indonesia (KTSP 2006 and Kurikulum Merdeka 2022) and one textbook from Singapore (New Syllabus Mathematics 2018). The method used is descriptive comparative with document analysis techniques. The focus of the study includes the presentation of facts, concepts, and principles, as well as question analysis based on Bloom's Taxonomy cognitive levels, alignment with the PISA framework, and problem-solving components. The results indicate that the Kurikulum Merdeka textbook stands out in its variety of cognitive levels (C1–C6) and integration of PISA-type questions. The KTSP textbook follows a more deductive approach and lacks higher-order thinking questions, while the Singaporean textbook balances inductive and deductive approaches but only covers C3–C4 levels. All three textbooks include problem-solving tasks with varying levels of complexity. These findings offer insights for the development of more effective and context-based mathematics textbooks.

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1. INTRODUCTION

Ki Hajar Dewantara, the Father of Indonesian National Education, defined education as "Guidance in the growth of children's lives. The purpose is to guide all the natural potentials within children so that they, as individuals and as members of society, can achieve the highest levels of safety and happiness." Education is an effort made by institutions to ensure that students develop good competencies and full awareness of social relationships and issues [1]. One important aspect of education is mathematics learning. Mathematics is essential and beneficial in all aspects of life [2]. It serves as a tool to develop logical, critical, and systematic thinking skills that are crucial in everyday life as well as in facing advances in science and technology [3]. Through mathematics education, students are trained to solve problems rationally and based on data [4]. Therefore, it is important to introduce mathematics learning from early levels of education [5].

Nevertheless, Indonesian students' achievement in mathematical literacy remains relatively low. According to the Programme for International Student Assessment (PISA), Indonesia's mathematics score was recorded at 366, significantly below the international average of 472. In contrast, Singapore achieved the highest score, 575, placing first globally. One contributing factor to this gap is the curriculum implemented in each country. Curriculum is a crucial element in education and teaching [6]. In Indonesia, several internationally oriented schools have adopted foreign curricula in efforts to improve learning quality and student outcomes [7]. The Indonesian curriculum has undergone numerous changes over time. These changes reflect the dynamics of national education policy adapting to social, economic, and scientific developments [8]. There is even a popular phrase "change the minister, change the curriculum," illustrating the high frequency of

curriculum revisions. From the first curriculum in 1947 to the latest "Kurikulum Merdeka" in 2022, several revisions have been made to develop an education system that responds to current challenges and prepares students for the future [9].

One important component in curriculum implementation is the textbook [10]. Textbooks are instructional media in schools that present material in a structured manner through stages, examples, and exercises [11]. They play a crucial role in supporting teaching and learning processes in the classroom, as they serve as the main reference for delivering content. Therefore, the quality of textbooks greatly influences the effectiveness of teaching and student learning outcomes [12], [13]. To assess how well textbooks achieve learning objectives, one relevant approach is to conduct comparative analyses of textbooks from different countries [14]. Several previous studies have examined the comparison between Indonesian and Singaporean mathematics textbooks. For instance, [7]compared the 2013 Curriculum textbook with a Singaporean textbook on the topic of Linear Equations in Two Variables (SPLDV), while [15] focused on the topic of Quadratic Equations, and [14] on the topic of Sets. These studies demonstrate how comparative analyses can reveal differences in curriculum emphasis, cognitive demands, and types of questions between Indonesian and Singaporean textbooks across various mathematics topics. Indonesia and Singapore were selected because they are neighboring countries in Southeast Asia but show significantly different results in international assessments such as PISA. Singapore consistently ranks among the top-performing countries in mathematics literacy, while Indonesia continues to face challenges in this area. In addition, many private and international schools in Indonesia adopt Singaporean textbooks or teaching approaches. Therefore, analyzing and comparing the mathematics textbooks of these two countries can provide valuable insights for efforts to improve mathematics education in Indonesia. However, to the best of the researchers' knowledge, no previous study has yet conducted a comparative analysis of two Indonesian curricula and a Singaporean textbook on the topic of polyhedrons, while concurrently analyzing their alignment with the PISA 2022 framework and their potential to foster students' problem-solving skills.

Different from previous studies that only compared two textbooks : one from Indonesia and one from Singapore this research provides a comparative analysis of three mathematics textbooks: two from Indonesia and one from Singapore. The Indonesian textbooks analyzed are from the School-Based Curriculum (KTSP 2006) and the Kurikulum Merdeka (2022). The selection of textbooks from two different curricula in Indonesia namely the School-Based Curriculum (KTSP 2006) and the Kurikulum Merdeka (2022) was intended to examine how the presentation of mathematics content in Indonesia has evolved in line with changes in national curriculum policy. Singaporean textbook used is the New Syllabus Mathematics (2018 edition). The subject analyzed is Polyhedrons. This study focuses on analyzing the presentation of facts, concepts, and principles in the three textbooks. In addition, it also analyzes the questions and example problems based on cognitive levels, their alignment with the PISA 2022 framework, and their capacity to train problem-solving skills. This research is important because textbooks serve as fundamental tools for delivering curriculum content and fostering students' mathematical understanding. Given the substantial gap in mathematical literacy between Indonesia and high-performing countries such as Singapore, as reflected in PISA results, it is crucial to investigate how textbooks contribute to these differences. Insights from this analysis can inform the development of more effective and engaging mathematics textbooks in Indonesia. The purpose of this study is to conduct a detailed comparative analysis of Indonesian and Singaporean mathematics textbooks on the topic of polyhedrons, focusing on the presentation of facts, concepts, and principles, the cognitive levels of questions, their alignment with the PISA 2022 framework, and their capacity to support students' problem-solving skills.

2. RESEARCH METHOD

The research method used in this study is a descriptive comparative method. According [16] descriptive comparative research is a type of research aimed at comparing the values of one or more variables. This study aims to compare three mathematics textbooks based on how the material is presented, particularly on the topic of polyhedrons (three-dimensional shapes with flat faces). The objects of the study are presented in Table 1.

Table 1. Research Objects

Title	Country	Author	Curriculum	Publisher	Year
Mudah Belajar Matematika untuk kelas VIII	Indonesia	Nuniek Avianti Agus	KTSP	National Center for Book Development, Ministry of National Education	2008
Matematika untuk SMP/MTs Kelas IX	Indonesia	Yosep Dwi Kristanto, Muhammad Taqiyuddin, Elyda Yulfiana, Indra Rukmana	Kurikulum Merdeka	Center for Book Development, Agency of Standards, Curriculum, and Assessment of Education	2022

 ISSN: 2964-075X (Print), 2962-7281 (On Line)

Mathematics 7th Edition 2	Singapura	Joseph Yeo, Teh keng seng, Loh Cheng yee, Ivy chow, Neo chai meng, Jacinth Liew	Singapore Curriculum	New Sylabus	2018

The data collection technique used in this study is document analysis, with the research objects being three mathematics textbooks. Data were collected by reading and identifying the content of the textbooks, which include two from Indonesia (KTSP 2006 and Kurikulum Merdeka 2022) and one from Singapore (New Syllabus Mathematics 2018). The primary focus of the data collection was on the presentation of material and exercises related to the topic of polyhedrons (three-dimensional shapes with flat faces). The data analysis was conducted in several stages: (1) a comparative analysis of the facts, concepts, and principles presented in the three books; and (2) an analysis of the questions and example problems, including their cognitive levels based on the revised Bloom's Taxonomy, their alignment with the PISA framework, and the presence of contextual problem-solving elements in those questions.

3. RESULT AND DISCUSSION

3.1 Presentation of the Material

This section presents the flow of material presentation on the topic of Polyhedrons (three-dimensional shapes with flat faces) in the three analyzed mathematics textbooks. The analysis focuses on how each textbook organizes and presents the elements of facts, concepts, and principles within the topic. The presentation of facts includes the introduction of objects and basic characteristics of three-dimensional shapes; concepts involve the systematic development of mathematical ideas; and principles include the interrelation between concepts that form generalizations or mathematical rules. The following is the result of the analysis regarding the structure and sequence of material presentation in the three textbooks under review.

3.1.1 Mathematics Textbook Based on the School-Based Curriculum (KTSP)

The presentation of Polyhedrons in the *Mudah Belajar Matematika* textbook (based on the KTSP curriculum) is organized into a dedicated chapter with a systematic discussion. The sequence of material presentation in the KTSP textbook is illustrated in Figure 1.

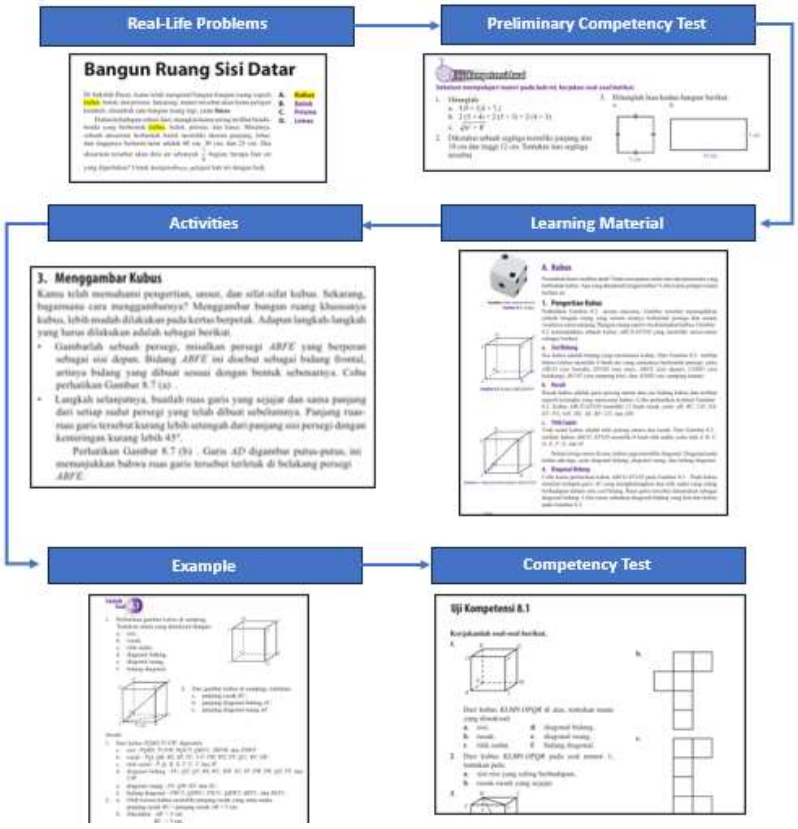

Figure 1. Flow of Material Presentation in the KTSP Textbook

Below is the description of how the topic of polyhedrons is presented in the KTSP mathematics textbook:

1. The material begins with a contextual problem aimed at exploring students' prior knowledge, typically presented through images or illustrations related to everyday life.
2. This initial problem guides students to recall previously learned concepts and serves as a foundation for the core content, which includes facts, concepts, and principles of polyhedrons such as cubes, cuboids, prisms, and pyramids.
3. Before entering the main material, the textbook provides a preliminary competency test consisting of questions on arithmetic operations and plane figures, which are relevant prerequisites.
4. The content is presented explicitly, starting from definitions and components of three-dimensional shapes, followed by example problems and step-by-step solutions. To encourage student engagement, the book includes learning activities such as drawing three-dimensional figures (e.g., cubes) and constructing physical models of the shapes.
5. The chapter ends with competency test problems designed to evaluate students' understanding and mastery of the material.

3.1.2 Mathematics Textbook Based on the Kurikulum Merdeka

The presentation of polyhedrons in the Kurikulum Merdeka mathematics textbook is included within a larger chapter that covers the entire topic of three-dimensional shapes, both polyhedrons and curved solids. However, the scope of this study is limited to the section discussing polyhedrons only. The following outlines the structure of material presentation in the Kurikulum Merdeka textbook.

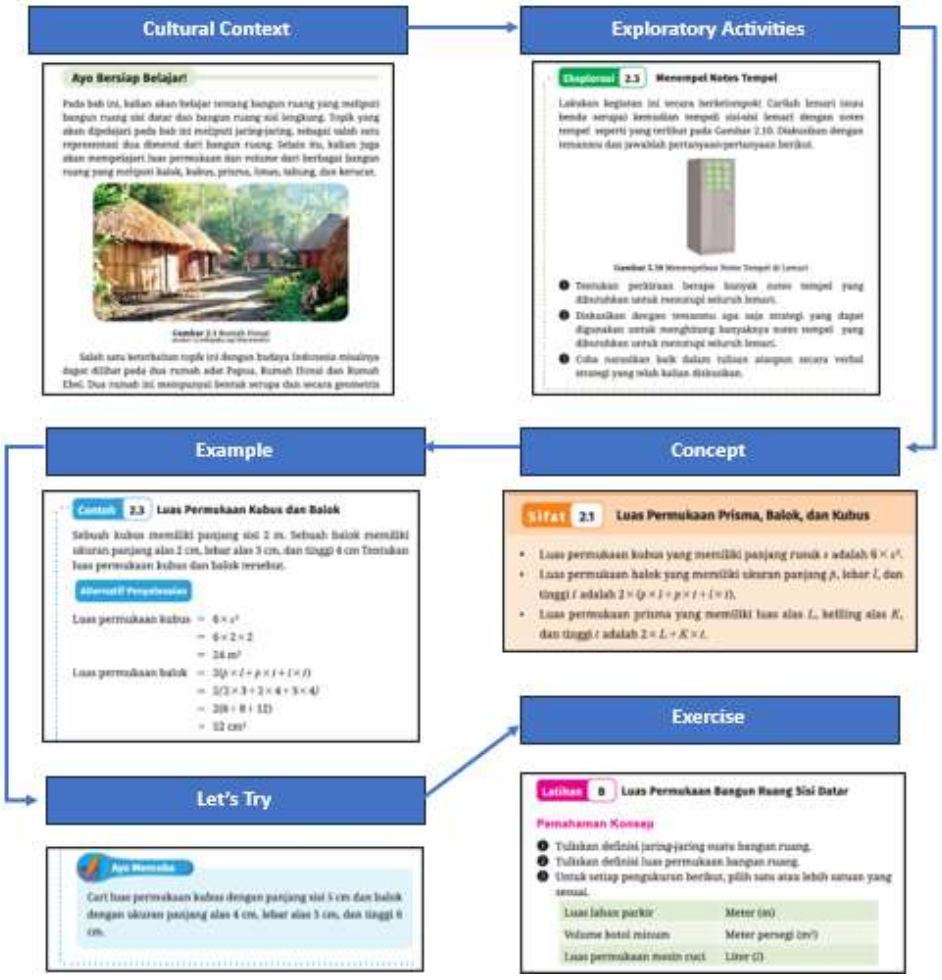

Figure 2. Flow of Material Presentation in the Kurikulum Merdeka Textbook

Below is the description of how the topic of polyhedrons is presented in the Kurikulum Merdeka mathematics textbook:

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1. The book begins the lesson by presenting Indonesian cultural contexts, such as the Hanoi House and Ebei House, which have structural similarities with polyhedral shapes. These contexts serve as starting points to stimulate students' understanding of geometric forms in real life.
2. After introducing the context, students are directly guided into exploratory activities, allowing them to construct conceptual understanding independently.
3. The outcome of these activities is concluded with the presentation of surface area formulas discovered through exploration.
4. The book then provides example problems and exercises in the "Ayo Mencoba" (Let's Try) section to reinforce concept mastery.
5. Finally, practice problems are presented to evaluate students' understanding of the material that has been studied.
6. The structure of the material in this textbook reflects an active, contextual, and meaningful learning approach, in line with the core principles of the Kurikulum Merdeka implementation.

3.1.3 Singapore Mathematics Textbook

The material on polyhedrons in this textbook is presented within the chapter on volume and surface area of prisms and cylinders. However, the focus of this study is limited to the polyhedron section only. The following outlines the flow of material presentation in the Singapore mathematics textbook.

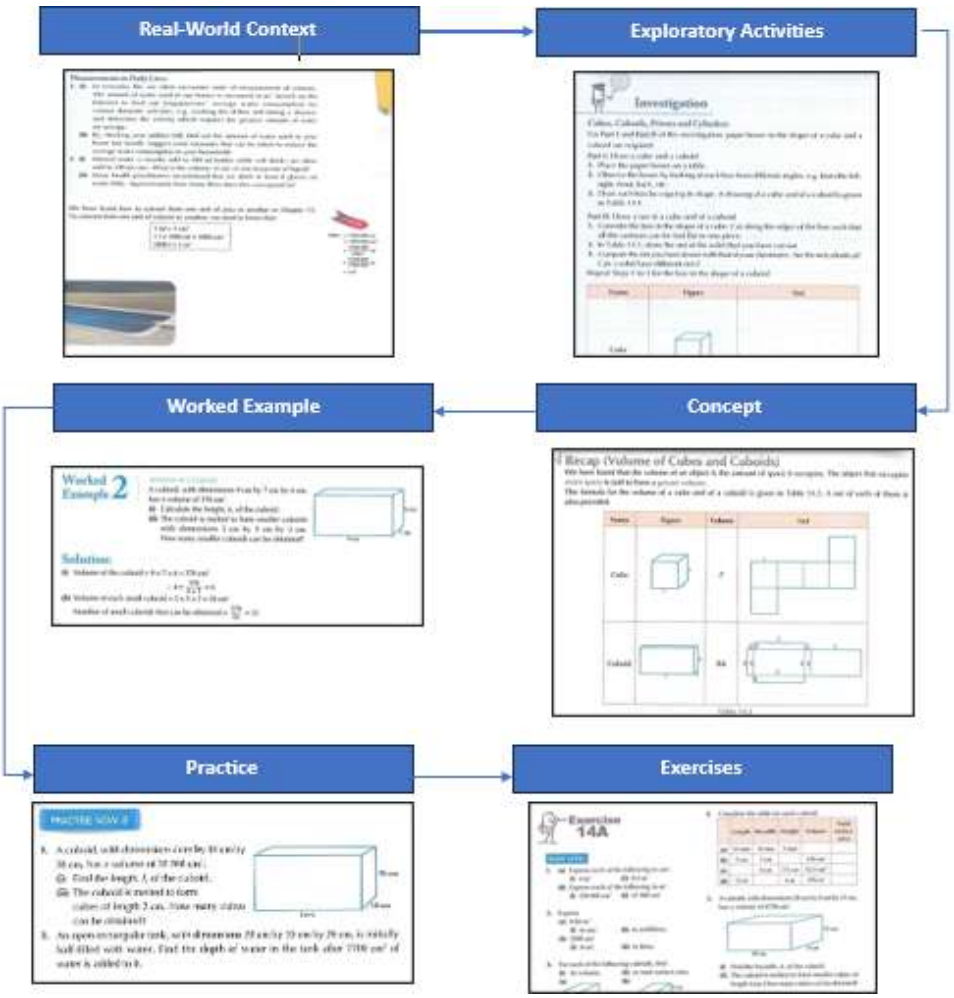


Figure 2. Flow of Material Presentation in the Textbook Singapore

Below is the description of how the topic of polyhedrons is presented in the Songapore mathematics textbook:

1. The book begins by introducing the importance of volume and surface area through real-life contexts, such as water management in Singapore. This approach builds interest and illustrates the relevance of the material.

2. The material continues with the introduction of basic terms, solid shapes, and their properties, such as the definitions of prisms and cylinders, as well as how to draw their nets. This serves as a foundation before engaging in calculations.
3. Once the basic concepts are understood, example problems are provided, covering calculations of volume and surface area, including appropriate methods and formula usage.
4. There are activities involving drawing nets of 3D shapes and constructing models, which help deepen visual and kinesthetic understanding.
5. A variety of practice problems are offered, including word problems and application-based tasks, to reinforce understanding and develop calculation skills.

Table 2. Comparison of Textbook Presentation

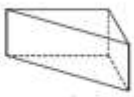
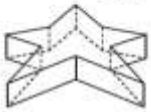
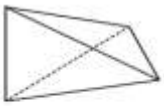
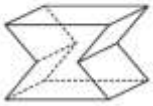
Aspect	KTSP Textbook	Kurikulum Merdeka Textbook	Singapore Mathematics Textbook
Presentation of Facts	Explicitly presented after the initial competency test. Facts are delivered through definitions and characteristics of solid shapes.	Presented through observations in exploratory activities based on local cultural contexts.	Presented through exploration and observation of concrete objects (models, nets, everyday items).
Presentation of Concepts	Concepts are introduced directly through explanations of definitions, components, and properties of 3D shapes.	Concepts are discovered independently through exploratory activities, and later explained explicitly.	Presented through a combination of inductive and deductive approaches: exploring nets, observing real objects, and discussing understanding.
Presentation of Principles	Principles are presented after the concepts, in the form of surface area and volume formulas, supported by example problems.	Principles are discovered by students through exploration and later summarized explicitly into formulas.	Principles are developed through discovery activities and "Thinking Time", then reinforced with explicit explanations and scaffolded exercises.
Sequence of Presentation	Recall → Contextual problem → Facts/concepts → Drawing activities → Concrete exploration → Final evaluation	Cultural context → Exploration → Concept discovery → Formula presentation → Examples → Exercises	Exploration of models/nets → Recap → Formula explanation → Thinking Time → Example problems → Scaffolded exercises

3.2 Questions Based on Bloom's Taxonomy Cognitive Levels

3.2.1 KTSP Textbook

Questions in the KTSP textbook are found only at levels **C1 to C4**. There are no questions at the higher-order thinking levels C5 and C6.

Table 3. Questions Based on Cognitive Levels in the KTSP

Question	Description	Level
1. Tentukan apakah bangun ruang berikut merupakan prisma atau bukan. Jika ya, tentukan jenis prisma yang dimaksud. a.  b.  c.  d. 	Students understand the characteristics of prisms and classify them based on images. The task does not require applying formulas or solving problems.	C2

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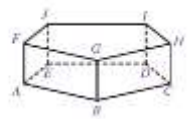
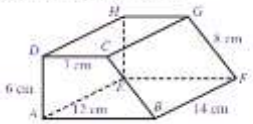
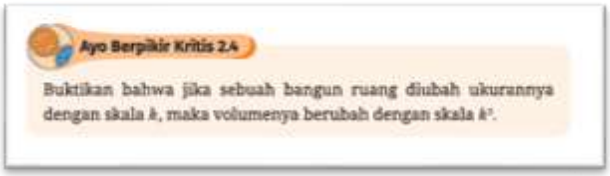
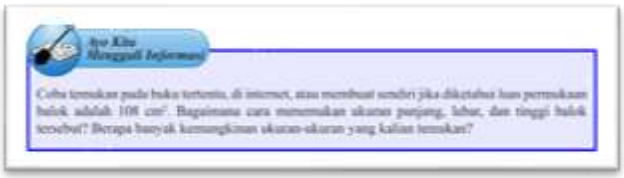
2.  Dari gambar prisma segilima di atas, tentukan unsur unsur berikut. a. Sisi/bidang b. Rusuk c. Titik sudut d. Diagonal bidang	Students are only asked to name the components; there is no further thinking process beyond recognition and identification.	C1
5. Perhatikan gambar berikut.  Dari gambar prisma segiempat tersebut, tentukan: a. panjang seluruh rusuk, b. luas alas prisma (luas *ABCD*), c. luas permukaan prisma *ABCD.EFGH*, d. volume prisma *ABCD.EFGH*.	Students apply geometric formulas in calculations based on diagrams.	C3
10. Sebuah kawat sepanjang 135 cm akan dibuat kerangka prisma segitiga. Jika panjang seluruh rusuk prisma segitiga tersebut memiliki ukuran yang sama panjang, tentukanlah: a. panjang rusuk dan tinggi prisma tersebut, b. luas permukaan prisma segitiga tersebut, c. volume prisma segitiga tersebut.	Students analyze information about the total length of wire and understand the structure of a triangular prism to determine side lengths, calculate surface area and volume—requiring decomposition of concepts and integrated application of formulas.	C4

3.2.2 Kurikulum Merdeka Textbook

The Kurikulum Merdeka textbook includes questions ranging from C1 to C6, indicating a more complete range of cognitive levels.

Table 4. Questions Based on Cognitive Levels in the Kurikulum Merdeka Textbook

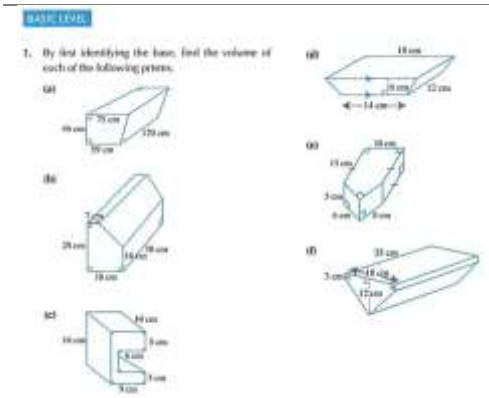
Question	Description	Level
Pemahaman Konsep ❶ Tuliskan definisi jaring-jaring suatu bangun ruang. ❷ Tuliskan definisi luas permukaan bangun ruang.	Students recall definitions of nets and surface area.	C1
❶ Bagaimana cara mencari luas permukaan kubus dan balok? ❷ Bagaimana cara mencari luas permukaan prisma dan limas?	The question assesses students' understanding of concepts and surface structure of 3D shapes.	C2
Penerapan Konsep ❶ Hitunglah volume dari tiap bangun berikut:  Gambar 2.34 Contoh Bangun Ruang	Students apply volume formulas to calculate based on diagrams.	C3

	Students not only calculate area but also analyze the relationship between scale changes and surface area.	C4
	Students evaluate and prove the validity of mathematical relationships using logical arguments and volume concepts.	C5
	Students are required to explore, attempt, and formulate possible solutions independently from limited information.	C6

3.2.3 Singapore Mathematics Textbook

Questions in the Singapore textbook are found only at C3 and C4, with no C1, C2, C5, or C6 questions identified.

Table 5. Questions Based on Cognitive Levels in the Singapore Textbook

Soal	Level	Keterangan
	C3	Students apply formulas to calculate the volume of 3D shapes based on diagrams.
15. A trough, in the form of an open rectangular box, is 1.85 m long, 45 cm wide and 28 cm deep externally. If the trough is made of wood 2.5 cm thick, find the volume of wood used to make this trough, giving your answer in m^3.	C4	Students analyze 3D shapes, compare volumes, and integrate data with different units.

3.3 Question based on the PISA framework

3.3.1. KTSP Textbook

No questions in the KTSP textbook were found to align with the PISA framework.

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3.3.2 Singapore Mathematics Textbook

The Kurikulum Merdeka textbook includes questions aligned with the PISA framework. One example is presented below:

Tabel 6. PISA-Aligned Question from the Kurikulum Merdeka Textbook

Soal	Keterangan
Contoh 2.9 Membangun Piramida Segi Enam Beraturan Kebanyakan piramida di Mesir memiliki alas persegi. Bayangkan jika kita ingin membangun sebuah piramida dengan alas heksagon atau segi enam beraturan (perhatikan Gambar 2.29) yang memiliki panjang sisi heksagon 6 m dan tinggi 8 m. Bahan bangunan yang akan digunakan adalah kubus bata beton dengan ukuran 10 cm × 10 cm × 10 cm. Untuk merencanakan pembangunannya, perkirakan berapa banyak bata beton yang dibutuhkan.  Gambar 2.29 Limas Heksagon	From the contextual perspective, the question is social in nature, as it relates to planning a building using real materials (concrete blocks), allowing students to connect it to real life. From the content perspective, it falls under the Space and Shape domain, as it involves a hexagonal pyramid and requires understanding geometry and volume calculation. Cognitively, students must formulate a mathematical model by calculating the base area and volume of the pyramid, then interpret the result to determine the number of concrete cubes needed. The question involves contextual problem-solving, as it cannot be solved directly using a simple formula students must go through several stages, such as identifying the shape, converting units, and estimating material quantities.

3.3.3 Singapore Mathematics Textbook

The Singapore textbook contains PISA-like questions. One example is as follows:

Table 7. PISA-Aligned Question from the Singapore Textbook

Soal	Keterangan
14. 2.85 million cubic metres of earth were required to fill the disused Sin Seng quarry at Rifle Range Road. (i) If each truck could carry a maximum load of 6.25 m^3 of earth per trip, how many trips were required to fill the entire quarry? (ii) The cost of transporting each truckload of earth was $55. How much did it cost to fill the quarry? (iii) Given that the site of the quarry has a land area of approximately 3 hectares, find the cost to fill 1 m^2 of the land. (1 hectare = 10 000 m^2)	This question is in a social context, dealing with filling former mining land using dump trucks and calculating construction costs. From the content domain, it falls under Quantity, focusing on calculations involving volume, cost, and unit conversion. Students are required to calculate the number of trips needed based on soil volume, perform multiplications to find total costs, and divide by area to determine cost per square meter. The question emphasizes arithmetic operations, proportions, and conversions rather than spatial or geometric aspects, clearly placing it in the Quantity domain, which is one of PISA's core areas.

3.4 Questions Based on Problem-Solving Skills

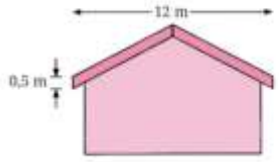
3.4.1 KTSP Textbook

Table 8. Problem-Solving Question from the KTSP Textbook

Question	Description
6. Sebuah akuarium berbentuk balok memiliki ukuran panjang, lebar, dan tinggi berturut-turut 60 cm, 36 cm, dan 45 cm. Jika akuarium tersebut diisi air sebanyak $\frac{3}{4}$ bagian maka volume air tersebut adalah …. a. 2.025 cm^3 c. 7.290 cm^3 b. 5.625 cm^3 d. 72.900 cm^3	This question does not directly ask students to use a formula but challenges them to first interpret given numerical information (length, width, and height of an aquarium, and 3/4 of it being filled with water). Students must devise an appropriate strategy, such as calculating the volume of the rectangular prism (aquarium), then multiplying by the given fraction. This process requires understanding of volume formulas and real-world context, as well as evaluating results against multiple-choice options testing reasoning and reflection skills.

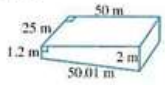
3.4.2 Kurikulum Merdeka Textbook

Table 9. Problem-Solving Question from the Kurikulum Merdeka Textbook

Question	Description
❶ Sebuah bahan kayu dipakai untuk pinggiran atap rumah sebagai berikut. Jika kayu ini memiliki ketebalan 8 cm, tentukan volume kayu yang dibutuhkan untuk pinggiran atap ini untuk satu sisi rumah yang ditampilkan.  Gambar 2.36 Ilustrasi Atap Rumah	This is a problem-solving question because to determine the volume of wood needed for a roof border, students must analyze the roof diagram to understand the dimensions of one side. They then apply volume calculations for a rectangular prism by identifying the total length, thickness (converted from 8 cm to meters), and width of the wood. The process involves visual interpretation, planning calculation steps, and applying the appropriate formula.

3.4.3 Singapore Mathematics Textbook

Table 10. Problem-Solving Question from the Singapore Textbook

Question	Description
5. A swimming pool is 50 m long and 25 m wide. It is 1.2 m deep at the shallow end and 2 m deep at the other end.  Find (i) the volume of water in the pool when it is full, (ii) the area of the pool which is in contact with the water.	This question falls under problem-solving because to answer both parts, students cannot rely on a single simple formula. They need to go through multiple analytical steps, involving understanding of solid geometry especially the volume of a trapezoidal prism and surface area of various shapes (rectangles, trapezoids, and slanted faces). The question requires interpreting information presented in text and diagrams, identifying relevant dimensions, selecting the appropriate formulas for each part, and combining the results to obtain the final answer.

4. CONCLUSION

The comparative analysis of three mathematics textbooks from Indonesia (KTSP and Kurikulum Merdeka) and Singapore reveals significant differences in how the topic of polyhedrons, particularly prisms and pyramids, is presented. Each textbook has distinct strengths and limitations in conveying facts, concepts, principles, and types of exercises. The KTSP textbook employs a systematic and explicit deductive approach, emphasizing formula memorization and direct application through examples. In contrast, the Kurikulum Merdeka textbook adopts a more contextual and exploratory method, drawing on local culture and student-centered activities to foster conceptual understanding. Meanwhile, the Singapore textbook integrates both inductive and deductive strategies, combining hands-on exploration, discussion, tiered exercises, and moments for reflection to deepen students' comprehension. In terms of cognitive levels based on Bloom's Taxonomy, the KTSP textbook covers only lower to mid-level thinking (C1–C4), while the Kurikulum Merdeka textbook spans all levels from C1 to C6, indicating a more comprehensive approach that supports higher-order thinking. The Singapore textbook focuses primarily on levels C3 and C4, reinforcing skills in application and analysis, but lacks representation at both the lower and higher ends of the taxonomy. Regarding alignment with the PISA framework, both the Kurikulum Merdeka and Singapore textbooks incorporate contextual problem-solving tasks that promote modeling, reasoning, and interpretation, whereas such integration is absent in the KTSP textbook. Lastly, all three textbooks include problem-solving elements to varying extents, with the Kurikulum Merdeka and Singapore textbooks providing more complex, multi-step problems that encourage decision-making based on real-world contexts. Based on the findings of this study, future researchers are encouraged to expand comparative textbook analyses by including other countries with high PISA scores, such as Chinese Taipei, Japan, or Korea, in order to gain broader insights into effective mathematics teaching practices. Furthermore, future studies could examine other aspects of textbooks, such as the integration of mathematical reasoning, the development of creativity, and the types of assessments provided, to offer a more comprehensive understanding of textbook quality and usefulness.

 ISSN: 2964-075X (Print), 2962-7281 (On Line)

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 ISSN: 2964-075X (Print), 2962-7281 (On Line)