Vol. 15, No. 03, pp. 1579-1603, 2025 DOI: 10.23960/jpp.v15i3.pp1579-1603

Jurnal Pendidikan Progresif

e-ISSN: 2550-1313 | p-ISSN: 2087-9849

http://jpp.fkip.unila.ac.id/index.php/jpp/

Comparative Analysis of Elementary Mathematics Textbooks on Geometry in Indonesia and the United States

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Received: 14 July 2025 *Accepted: 30 July 2025* *Published: 13 August 2025*

Abstract: Comparative Analysis of Elementary Mathematics Textbooks on Geometry in Indonesia and the United States. Objectives: This study aims to describe a comparison between elementary mathematics textbooks from Indonesia and the United States, focusing on geometry content. The analysis covers mathematical content based on Van Hiele's levels of geometric thinking and Gracins' framework, including mathematical activities, task complexity levels, response formats, and contextual features. **Methods:** A qualitative approach was employed, using coding and content recording techniques on Indonesian mathematics textbooks (*Matematika SD/MI*) and the *Go Math!* series from the United States across all elementary grade levels. Horizontal and vertical analyses were conducted. Inter-rater reliability was tested using Fleiss' Kappa via JASP software, yielding high agreement levels ranging from "almost perfect" to "substantial" across all dimensions. **Findings:** The results indicate that *Go Math!* has a greater number of pages, emphasizes reasoning and conceptual connections, and is dominated by closed-ended tasks. Indonesian textbooks tend to focus more on geometric shapes and properties, with a stronger presence of realistic contextual applications. Notably, there is no geometry content in *Go Math!* Grade 6 (2023 edition). **Conclusion:** This study contributes to the international discourse on textbook design and curriculum policy. The comparison reveals differing instructional approaches to geometry between developing and developed countries. The applicability of the Van Hiele and Gracins' frameworks across educational contexts is affirmed. Differences in contextual features also highlight the influence of local culture on mathematical content presentation. The absence of geometry in the final elementary grade in the U.S. curriculum points to a potential learning gap. This study recommends the development of more progressive mathematics textbooks that include varied activities, open-ended tasks, and meaningful contexts. It also encourages further comparative research across different content domains as a foundation for global mathematics education reform.

Keywords: textbook research, mathematics, geometry, indonesia, united states.

To cite this article:

Puspitaningrum, R., & Purnomo, Y. W. (2025). Comparative Analysis of Elementary Mathematics Textbooks on Geometry in Indonesia and the United States. *Jurnal Pendidikan Progresif*, *15*(3), 1579-1603. doi: 10.23960/jpp.v15i3.pp1579-1603.

INTRODUCTION

Textbooks remain essential to mathematics education worldwide, serving not only as instructional tools for teachers and learners but also as instruments for implementing curriculum and shaping students' mathematical experiences (Fan, Zhu, & Miao, 2013; Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). The structure, content, and pedagogical design of textbooks significantly influence how learners engage with mathematical concepts, especially in the early years of schooling (Zhang, 2021). Textbooks have a crucial role in education, especially in mathematics education, because

mathematics is an abstract science that is difficult to understand or comprehend without learning resources such as textbooks. Hence, mathematics textbooks are essential for students to understand various important information about mathematics education (Celik, 2020). So far, teachers have used textbooks to plan learning activities in class. If the quality of textbooks used is low, students may have low abilities and have difficulty working on questions (Alim, Hermita, Alim, Wijaya, & Pereira, 2021).

Mathematics is a subject that involves all levels of education, especially elementary education. Mathematics plays a crucial role in the learning process, supporting the development of individual intelligence (Firdaus, Fadhilah, Wuryandari, & Fadhli, 2024). In addition, mathematics plays an important role in the world of education as a provision for students to face various challenges in an ever-changing era (Arifin, Wahyudin, & Herman, 2020). Geometry is a foundational component in primary mathematics that contributes to students' spatial reasoning, visualization, and higher-order thinking skills (Hiele, 1999; Usiskin, 1982). Despite its importance, international research has documented persistent difficulties among elementary students in mastering geometric concepts (Altýparmak, Kemal, and Gürcan, 2021; Duranovic & Didic, 2023). There is empirical evidence that the geometric concept is a challenging learning experience, so it is rarely used in research (Annizar, Maulyda, Khairunnisa, & Hijriani, 2020). Many elementary school students tend to have a weak understanding of geometric concepts because they are not given context-based problems (Pramudiani, Oktafiani, Aziz, & Purnomo, 2017). These difficulties may not solely stem from student-related factors, but are also strongly influenced by the quality of textbook design. One contributing factor is the nature of geometry content and tasks provided in textbooks, which often prioritize procedural knowledge over conceptual understanding and contextual relevance (Chang & Silalahi, 2017; Gracin, 2018). When tasks are limited in cognitive depth, lack variety in mathematical activity, or are disconnected from meaningful contexts, they may restrict students' ability to build deep and transferable geometric understandings. This is in line with a study by Saputro et al. (2023), which revealed that the students' difficulties often encountered in learning geometry, especially the geometry of plane shapes, are difficulties in understanding the characteristics of plane shapes due to difficulties in understanding and a lack of reading skills.

Comparative textbook studies offer critical insights into how different educational systems construct mathematical knowledge and provide opportunities to reflect on pedagogical priorities, curriculum coherence, and equity in learning experiences (Fan et al., 2013; Yang, Li, & Jia, 2024). In this context, the study of geometry concepts holds particular urgency, given that geometry plays a crucial role in developing students' spatial understanding, logical reasoning, and visualization skills from the early stages of education. Unfortunately, comparative studies that specifically examine geometry content in elementary mathematics textbooks remain limited especially those employing structured frameworks such as the Gracins' Framework and Van Hiele's levels of geometric thinking. Therefore, this research is relevant for enriching the literature and supporting improvements in the quality of geometry education across countries.

A review of the literature reveals several relevant studies that underpin this research and help avoid duplication. First, the study by Yang et al. (2024) compared fraction content in elementary mathematics textbooks across six countries, including the United States. The research analyzed operational meanings and

reasoning methods in fraction division and found significant differences among the textbooks. It employed a content analysis and comparative approach. The key difference from the present study lies in its focus on fractions rather than geometry. At the same time, the similarities include the use of a qualitative approach and an analysis of U.S. textbooks. Second, Asmaroud (2023) compared Iranian and U.S. mathematics textbooks in terms of fraction content, frequency, and cognitive demand in Grades 2 and 3, using the Levels of Cognitive Demand (LCD) framework. This study also adopted a qualitative document analysis approach. The difference lies in the focus and aim of the content, while the similarities include the methodology, the inclusion of U.S. materials, and the use of Go Math! textbooks.

Although several studies have compared textbooks across countries, the focus on geometry content in primary education remains limited, particularly those using systematic frameworks to assess dimensions such as cognitive complexity, mathematical activity, and contextualization. Therefore, the present study aims to address this gap by conducting a more in-depth and structured comparison of elementary mathematics textbooks from Indonesia and the United States. This study contributes to this gap by conducting a multi-dimensional comparative analysis of geometry content in elementary mathematics textbooks from Indonesia and the United States. Using Gracins' five-dimensional framework and Van Hiele's levels of geometric thinking, the study investigates how geometry tasks are presented in terms of depth of reasoning, variety of activity, and connection to real-world contexts. The combination of these two frameworks is considered appropriate because it allows for a thorough exploration of the cognitive, pedagogical, and contextual aspects of the geometry content in textbooks.

Given the disparities in student performance in large-scale assessments such as PISA 2022, where Indonesian students scored well below the OECD average, a closer examination of how geometry learning is structured in textbooks becomes increasingly critical. Understanding how textbooks structure geometric learning is crucial. This research aims to inform curriculum designers, textbook developers, and educators about the strengths and limitations of current materials and their implications for improving the quality of mathematics instruction. To gain a deeper understanding of how mathematics textbooks present geometry content in two distinct educational contexts, this study addresses the following research questions:

1. How does the mathematical content of geometry in Indonesian and United States mathematics textbooks compare in terms of Van Hiele's levels of geometric thinking (visualization, analysis, informal deduction, formal deduction, and rigor)?
2. How do the mathematical activities in geometry tasks differ between Indonesian and United States mathematics textbooks, based on the categories of representation and modeling, computation and operations, interpretation, and reasoning and argumentation?
3. How does the level of task complexity in geometry differ between Indonesian and United States mathematics textbooks, in terms of direct application of basic knowledge and skills, building and handling connections, and reflective application of knowledge?
4. How do the types of response formats in geometry questions compare between Indonesian and United States mathematics textbooks, particularly in terms of open-ended, closed-ended, and multiple-choice formats?
5. How do the contextual features of geometry tasks in Indonesian and United States

mathematics textbooks differ, based on the categories of non-application, realistic application, and authentic application?

METHOD

Research Design

The research approach used in this study was qualitative, namely coding and recording the analysis result (Purnomo, Prananto, & Rakhmawati, 2023). This study compared mathematics textbooks with geometry content in elementary schools from two countries: Indonesia and the United States.

Textbook Selection Strategy

The Ministry of Education in Indonesia has established books that are used at various levels of education in Indonesia, especially at the elementary school level, which were published in 2022. In the United States, there is no uniform national math textbook. Each school is free to choose various types of math textbooks that are tailored to the abilities of students and the context of each school. This study used the book Go Math! published by Houghton Mifflin in 2023. This book is one of the most popular and frequently used textbooks in public schools in California and other states in the United States. The use of English as the language of instruction also facilitates the analysis process by researchers. This study focuses on the geometry content in the two countries' books at all elementary school grade levels. This study chose to use the Go Math! book because it is the latest publication from Houghton Mifflin Harcourt in 2023, one of the largest educational publishers in the United States since 1921. This book features updated content compared to the series in other states and is easily accessible online. Although the student book is not available in full, researchers can still use it through the teacher's book, which contains excerpts of student material, making it more cost-effective.

Data Collection Techniques and Instruments

This study used coding and recording methods for analysis results (Purnomo et al., 2023). Both the Indonesian and the United States education systems are decentralized. Indonesia has the "*Merdeka*" Curriculum, which gives schools freedom to design learning, while the US lacks a national curriculum, as curriculum authority rests with each state. Both countries also implement 12 years of compulsory education in some regions. Mathematics textbooks are organized by grade level. In Indonesia, the textbook analyzed was the Elementary/Islamic Elementary School Mathematics series published by the Ministry of Education, Culture, Research, and Technology in 2022, while in the US, it was the Go Math! textbook published by Houghton Mifflin in 2023.

This study analyzed the geometry content of both textbooks using Gracins' framework, which encompasses five dimensions: Mathematical Content, Mathematical Activity, Complexity Level, Answer Form, and Context (Gracin, 2018). Specifically for Mathematical Content, the analysis was based on Van Hiele's theory (Hiele, 1999; Usiskin, 1982), which includes five levels: Visualization, Analysis, Informal Deduction, Formal Deduction, and Geometric Rigor. The operational definition used in this study states that a "task" or "problem" is defined as any explicit request for students to perform a specific mathematical activity, whether in the form of a practice problem, a project, an exploration, or an open-ended or closed-ended question, either standing alone or as part of a sequence. This definition was applied consistently by all raters throughout the coding process.

Each textbook was coded based on this framework, and then an analysis was conducted to compare the characteristics of the geometric content in elementary mathematics textbooks from both countries. The coding instrument is presented in Table 1.

Table 1. Research instruments based on the gracins' framework

Dimensions	Question	Details and Code
Mathematical Content	How does the mathematical content of geometry in Indonesian and United States mathematics textbooks compare in terms of Van Hiele's levels of geometric thinking (visualization, analysis, informal deduction, formal deduction, and rigor)?	Visualization (T1) Analysis (T2) Informal Deduction (T3) Formal Deduction (T4) Rigor (T5)
Mathematical Activities	How do the mathematical activities in geometry tasks differ between Indonesian and United States mathematics textbooks, based on the categories of representation and modeling, computation and operations, interpretation, and reasoning and argumentation?	Representation and modeling (A1) Computation and operations (A2) Interpretation (A3) Reasoning dan argumentation (A4)
Complexity Level	How does the level of task complexity in geometry differ between Indonesian and United States mathematics textbooks, in terms of direct application of basic knowledge and skills, building and handling connections, and reflective application of knowledge?	Direct application of basic knowledge (L1) Building and handling connections (L2) Reflection (L3)
Answer Form	How do the types of response formats in geometry questions compare between Indonesian and United States mathematics textbooks, particularly in terms of open-ended, closed-ended, and multiple-choice formats?	Open-ended (J1) Close-ended (J2) Multiple-choice (J3)
Contextual Features	How do the contextual features of geometry tasks in Indonesian and United States mathematics textbooks differ, based on the categories of non-application, realistic application, and authentic application?	Non-Application (C1) Realistic application (C2) Authentic Application (C3)

Data Validity

The data validity in this study refers to concepts developed from validity and reliability, adapted to a qualitative paradigm (Moleong, 2017). Testing was conducted using interrater reliability, which is the level of agreement between raters (Jaya & Warti, 2022). The three raters involved were a recent master's graduate, a master's student, and a certified elementary school teacher. They had been previously trained and began analysis in December 2024.

Coding based on Table 1 was used as a guide in analyzing Indonesian and US textbooks. The analysis results were compared using Fleiss' Kappa, which is appropriate for three raters and nominal data. Interpretation of Kappa values:

<0.00 (Poor), 0.00–0.20 (Slight), 0.21–0.40 (Fair), 0.41–0.60 (Moderate), 0.61–0.80 (Substantial), and 0.81–1.00 (Almost Perfect). The results of the Fleiss' Kappa Test with the help of the JASP application can be seen in Table 2.

Table 2. Results of rater agreement between indonesian and united states mathematics books

Student Activities	"Matematika SD/MI" Indonesia		*Go Math!* United States	
	Analysis Results	Discussion Results	Analysis Results	Discussion Results
Mathematical Content	0.091	0.848	0.361	0.875
Mathematical Activities	0.443	0.794	0.428	0.783
Complexity Level	0.395	0.749	0.424	0.795
Answer Form	0.617	0.862	0.564	0.907
Contextual Features	0.315	0.963	0.414	0.747
Total	**1.861**	**4.216**	**2.191**	**4.107**

Based on Table 1, the three raters analyzed mathematics textbooks from Indonesia and the United States on five aspects: mathematical content, mathematical activities, complexity level, answer format, and contextual features. Initial results for the Indonesian textbooks indicated a low to moderate level of agreement, with Kappa values ranging from 0.091 (Slight) to 0.617 (Substantial). After the discussion, the level of agreement increased significantly, with Kappa values ranging from 0.748 to 0.963 (Substantial–Almost Perfect).

For the Go Math! textbook (United States), initial results indicated rater agreement in the Fair to Moderate category (0.361–0.564). After the discussion, agreement increased from Substantial to Almost Perfect (0.747–0.907). Discussions were conducted to reconcile differences in coding & ensure analytical agreement across all aspects.

Data Analysis

A comparative analysis of selected elementary school mathematics textbooks with geometry content. A qualitative approach was used by coding and recording the results of the comparative analysis of the textbooks studied. This research used horizontal and vertical analysis (Charalambous, Delaney, Hsu, & Mesa, 2010). Horizontal analysis in this study refers to the examination of general characteristics of the textbooks, such as the title, author, publisher, year of publication, total number of pages, and the proportion of geometry content relative to the overall textbook content (Purnomo, Julaikah, Hapsari, Oktavia, & Iksan, 2024). The purpose of this analysis is to provide contextual background on the physical structure and content scope of the textbooks, offering readers an initial understanding before delving into content-specific analysis. Meanwhile, vertical analysis focuses on an in-depth exploration of the geometry content within the textbooks by systematically examining each task or learning activity. For this analysis, the study employed Gracins' five-dimensional framework (Gracin, 2018), which includes:

1. Mathematical activity (representation and modeling, computation and operations, interpretation, and reasoning/argumentation);
2. Level of complexity (direct application,

constructing and dealing with connections, reflection);
3. Answer Form (open-ended, closed, multiple-choice);
4. Contextual features (non-application, realistic application, authentic application); and

In addition, this analysis is enriched by incorporating the Van Hiele levels of geometric thinking (Duranovic & Didic, 2023; Usiskin, 1982), which categorize students' geometric reasoning into five hierarchical levels: visualization, analysis, informal deduction, formal deduction, and rigor.

The combination of these two analytical frameworks enables a comprehensive investigation into the conceptual depth, pedagogical orientation, and contextual relevance of geometry tasks, thus providing deeper insight into how textbooks shape students' mathematical learning experiences. A specific explanation of the data analysis used in this study can be seen in Table 3.

Table 3. Framework for analysing geometry materials

Dimension	Analysis Component	Category
Horizontal	General characteristics	Title, author, publisher, year of publication, number of pages, and portion of geometry material.
Vertical	Mathematical Content	Visualisation (T1)
		Analysis (T2)
		Informal Deduction (T3)
		Formal Deduction (T4)
		Geometric Rigor (T5)
	Mathematical Activity	Representation and modeling (A1)
		Calculations and operations (A2)
		Interpretation (A3)
		Argumentation and Reasoning (A4)
	Complexity Level	Direct application of basic knowledge and skills (L1)
		Constructing and dealing with connections (L2)
		Reflection (L3)
	Answer Form	Open Answer (J1)
		Closed Answer (J2)
		Multiple Choice (J3)
	Contextual Features	Non-Application (C1)
		Realistic Application (C2)
		Authentic Application (C3)

■ RESULT AND DISCUSSION

Overview of the Compared Textbooks

The Indonesian elementary mathematics textbooks and the Go Math! books from the United States are both organised by grades I to VI, so there are six books each. A total of twelve books were analysed, and their backgrounds are listed in Table 4.

Based on Table 4, the Indonesian math textbooks were published by the Ministry of Education, Culture, Research, and Technology in 2022, while Go Math! was published by Houghton Mifflin in 2023. The Indonesian book's author is listed by level, whereas the Go Math! book does not include the author's name. The Indonesian book can be accessed through the

Table 4. Comparison of Indonesian and US book background information

Grade	Indonesia	Amerika Serikat
I	Title: *Matematika untuk SD/MI Kelas I* Author: Wulan & Rasfaniwaty Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 252 Number of pages of geometry content: 19	Title: Go Math! Grade 1 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 751 Number of pages of geometry content: 73
II	Title: *Matematika untuk SD/MI Kelas II* Author: Wulan & Rasfaniwaty Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 260 Number of pages of geometry content: 35	Title: Go Math! Grade 2 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 766 Number of pages of geometry content: 49
III	Title: *Matematika untuk SD/MI Kelas III* Author: Susanto, et.al. Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 230 Number of pages of geometry content: 51	Title: Go Math! Grade 3 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 786 Number of pages of geometry content: 39
IV	Title: *Matematika untuk SD/MI Kelas IV* Author: Hobri, et.al. Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 212 Number of pages of geometry content: 38	Title: Go Math! Grade 4 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 786 Number of pages of geometry content: 89
V	Title: *Matematika untuk SD/MI Kelas V* Author: Fitrianawati, Surtiani, & Istiandaru Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 312 Number of pages of geometry content: 72	Title: Go Math! Grade 5 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 680 Number of pages of geometry content: 32
VI	Title: *Matematika untuk SD/MI Kelas VI* Author:Susanto, et.al. Publisher: Ministry of Education, Culture, Research, and Technology of Indonesia Year of Publication: 2022 Number of book pages: 146 Number of pages of geometry content: 23	Title: Go Math! Grade 6 Publisher: Houghton Mifflin Year of Publication: 2023 Number of book pages: 570 Number of pages of geometry content: 0

website https://buku.kemdikbud.go.id, while Go Math! through https://thecurriculumstore.com, although the site can only be accessed in the US region. Therefore, researchers obtained Go Math! flipbooks for grades I-IV and teachers' books for grades V to VI. In general, the

Indonesian book has fewer pages than Go Math! because the US book contains more material in each chapter and is divided into two volumes. Analysis of the geometry material shows that the Indonesian book has several geometry pages varying from 19 to 72 pages per level, while Go Math! ranges from 32 to 89 pages, with grade 6 containing no geometry material.

One of the most striking findings in this analysis is the absence of explicit geometry content in the 6th-grade Go Math! textbook. This omission is of serious concern as it directly contradicts recommendations from international bodies such as the National Council of Teachers of Mathematics (NCTM) and the Trends in International Mathematics and Science Study (TIMSS), which emphasize the importance of the continuous development of geometric concepts throughout elementary school. The NCTM, in its Principles and Standards for School Mathematics, states that geometry instruction should begin early and be progressively expanded to include recognition and exploration of geometric properties, spatial relationships, transformations, and informal proofs. TIMSS also explicitly includes geometry as a core domain to be taught at every elementary school grade level. The absence of this material in the 6th-grade curriculum can be speculated to be a result of the US curriculum's emphasis, particularly in the Common Core State Standards (CCSS), on strengthening arithmetic understanding and preparing for algebra in the upper grades. While this approach aims to deepen numerical skills as a foundation for algebra, the complete omission of geometry in the later stages of elementary school creates a structural gap that is unusual by international standards.

As a result, students miss out on crucial opportunities to develop spatial reasoning and grasp complex geometric relationships, which should act as a bridge to formal geometry learning at the secondary level. This absence also risks widening the gap in students' readiness for topics such as transformations, proofs, and coordinate geometry, which are important focuses at later stages. Thus, this gap is not simply a local curriculum issue, but a violation of international pedagogical principles that recommend continuity and integration in the development of geometric competencies.

Differences in Geometric Thinking and Reasoning

The mathematical content was analysed based on Van Hiele's levels of thinking: Visualisation (T1), Analysis (T2), Informal Deduction (T3), Formal Deduction (T4), and Geometric Rigor (T5). The Indonesian math book consists of one book per school year, while Go Math! consists of two volumes. The geometry material in the Indonesian book includes seven chapters and 20 sub-materials, while Go Math! contains seven chapters with 38 lessons. The categorization of geometry mathematical content is presented in Figure 1.

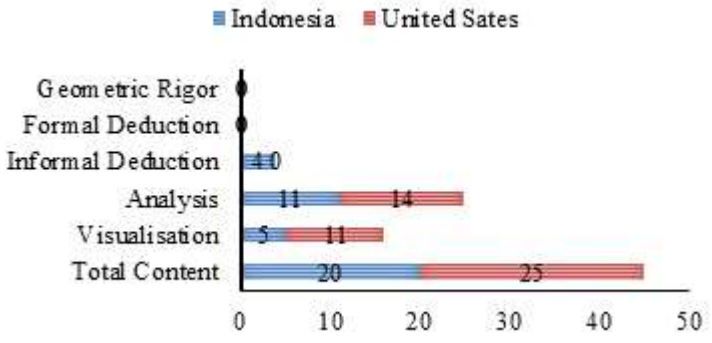


Figure 1. Categorisation of mathematical geometry content of Indonesian and US books

Based on Figure 1, geometry content in Indonesian elementary school mathematics books is dominated by Level 2 Analysis (T2) with 11 materials (55%), mainly in Grade 5 (5 contents) and followed by Visualization (T1) with five materials (25%) mainly in Grade 1 (3 contents), and Informal Deduction (T3) with four materials (20%) with dominance in grade 6 (3 contents). No content was found at Grades 4 and 5, in accordance with Van Hiele's (1986) theory that these grades appear at the intermediate level (Duranovic & Didic, 2023; Johnson, Mason, & Adelson, 2021).

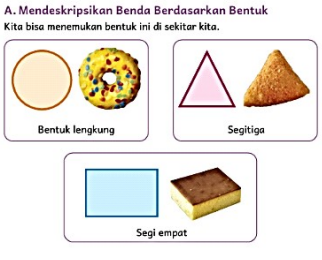
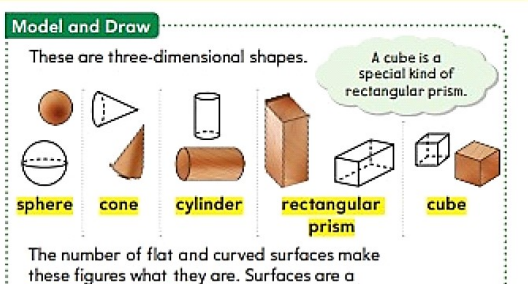
Meanwhile, in the US, Go Math! book, Analysis (T2) also dominates with 14 contents (56%), especially in Grade 4 (6 contents), followed by Visualisation (T1) with 11 contents (44%), with Grade 1 as the most (7 contents). No Informal Deduction (T3) content was found, nor higher levels. The informal deduction (T3) found in elementary school mathematics textbooks in Indonesia, particularly in sixth grade, can be understood as a precursor to more formal mathematical argumentation. Within Van Hiele's theoretical framework, the informal deduction level marks the stage when students begin to understand the properties of shapes and draw conclusions based on logical relationships. However, they do not yet use rigorous, formal proofs.

At this stage, students may not yet be able to write arguments in formal deductive forms such as syllogisms or complete mathematical proofs, but they are already beginning to construct reasoning, explain why one property occurs based on another, and make limited generalizations from their observations. This is an important foundation for the development of mathematical argumentation skills, as emphasized in international curricula like the Common Core State Standards (CCSS) and by experts like Umland (2020), who view argumentation as a key aspect of mathematical literacy.

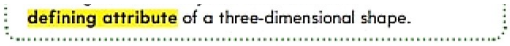
Therefore, the Informal Deduction content in Indonesian textbooks has the potential to bridge the gap between concept introduction and the development of logical argumentation skills, or even serve as a foundation for mathematical communication and justification competencies at higher levels. While not explicitly covered as "argumentation" in CCSS terms, these informal deductions functionally demonstrate an early awareness of logical structures, which is crucial for developing more mature argumentation skills.

Conversely, the absence of informal deduction (T3) content in Go Math! suggests that students may lack explicit opportunities to develop early forms of deductive reasoning, which could ultimately result in delays or weaknesses in developing argumentative skills in geometry topics at later levels. The following are examples of geometry content analysed descriptively and presented in the form of Table 5.

Table 5. Categorisation of material: examples of Indonesian and US mathematics books

Visualization	
Indonesian Mathematics Textbook	Go Math! Book United States
	

Found in Grade 1 in the topic "*Mendeskrispsikan benda berdasarkan Bentuk*" page 118.



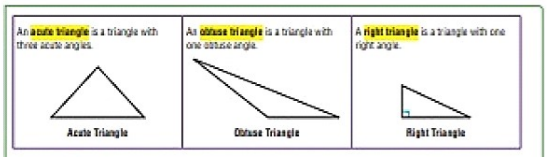
Found in Grade 1 Chapter 12 Lesson 1 in the topic *Three-Dimensional Shapes,* page 546.

Analysis

Indonesian Mathematics Textbook

Found in Grade 5 in the topic"Pengertian Sudut", pages 170-171.

Go Math! Book United States



Found in Grade 4 Chapter 14 Lesson 2 in the topic *Classify Triangles by Angles,* page 566.

Informal Deduction

Indonesian Mathematics Textbook

Go Math! Book United States

in the Go Math! book United States on Geometry material has no content at the geometric thinking level, Informal Deduction.

Based on Table 5, both textbooks are dominated by tasks at the Analysis level of Van Hiele's framework (Level 2), suggesting a shared emphasis on recognizing properties and classifying shapes. However, the Indonesian textbook includes a higher proportion of tasks at the

Informal Deduction level (Level 3), indicating a greater attempt to relate properties and infer conclusions about shapes. This is significant, as such tasks can serve as a bridge to formal reasoning and proof (Usiskin, 1982). These findings align with the approach in the Independent Curriculum, which emphasizes the importance of developing critical thinking and reasoning in mathematics learning. The presence of questions at the Informal Deduction level reflects an effort to gradually and continuously develop students' ability to understand the logical structure of geometric concepts.

In contrast, Go Math! does not include content beyond the Analysis level, reflecting the focus of the US curriculum, particularly the CCSS, on systematic and measurable understanding of fundamental geometric concepts, but not the explicit emphasis on developing formal deductive reasoning at the elementary level. As a result, students may be limited in developing deeper geometric thinking before entering secondary education. Thus, the differences in Van Hiele's levels in the two books reflect differences in curriculum philosophies: the Indonesian curriculum, which gradually opens up space for the development of deductive reasoning, and the US curriculum, which is more cautious in introducing logical structures at a more advanced level.

Mathematical Activities and Higher-Order Thinking

Mathematical activities in the textbook are categorised into four types: Representation & Modelling (A1), Calculation & Operation (A2), Interpretation (A3), and Argumentation & Reasoning (A4), as listed in Figure 2.

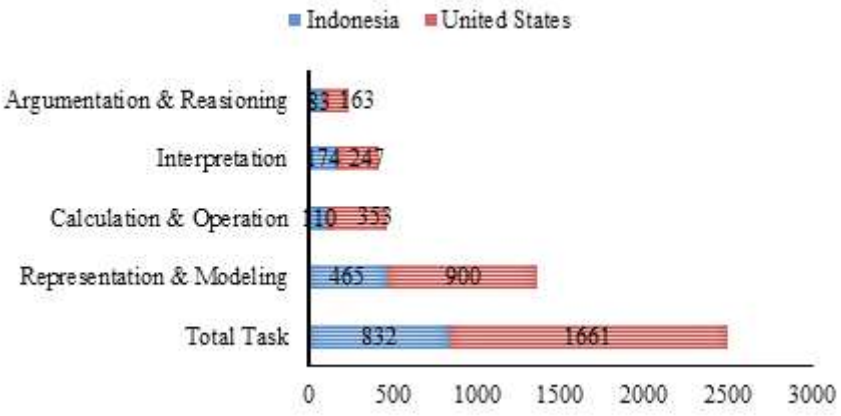


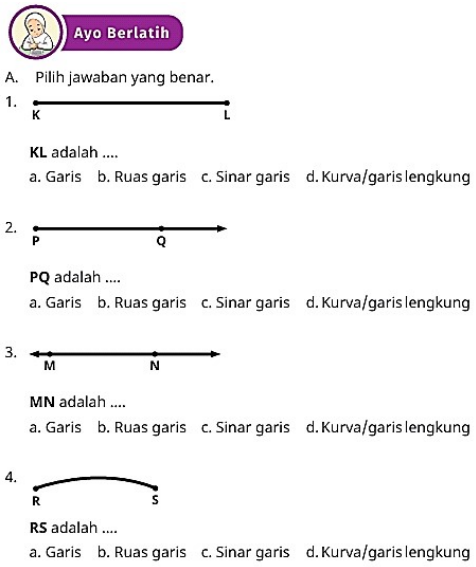
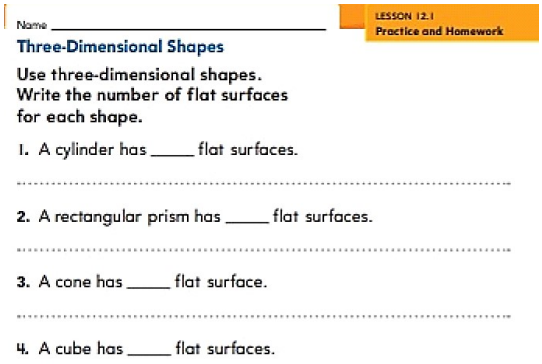
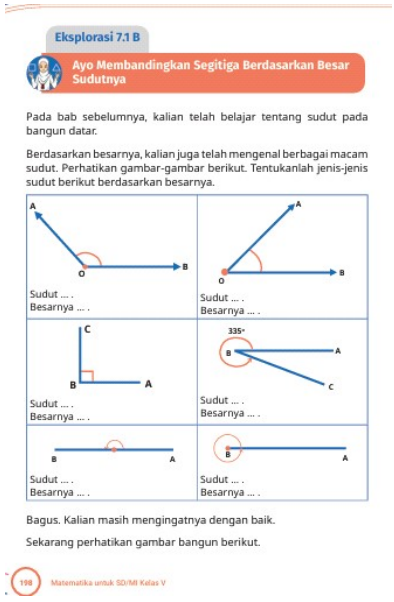
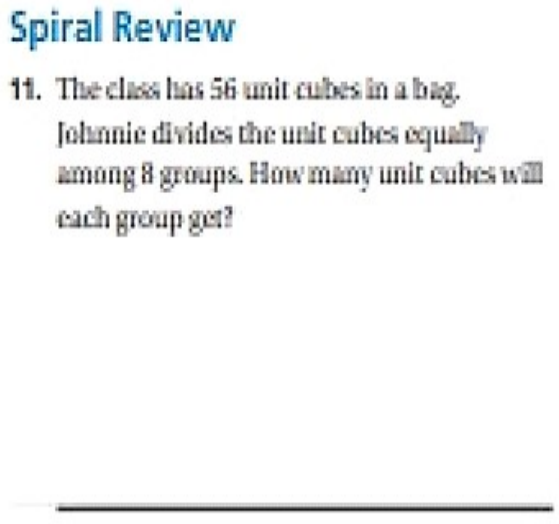
Figure 2. Mathematical activity categorization of Indonesian and US books

Based on Figure 2, out of a total of 832 tasks in Indonesian mathematics textbooks, most of them are in the Representation and Modelling category (A1) with 465 tasks (55.89%), mainly in Grade 3 in learning activities "*Ayo Berlatih*" (66 tasks). The Calculation and Operation category (A2) ranks second with 110 tasks (13.22%), most in Grade 5 in learning activities "*Ayo Membandingkan*" (15 tasks). The Interpretation (A3) category amounted to 174 tasks (20.91%), dominant in Grade 5 in the same activity (97 tasks). Meanwhile, the Argumentation and Reasoning category (A4) was the least with 83 tasks (9.98%), mainly in Grade 4 in learning activities "*Ayo Beraktivitas*"(22 tasks).

Meanwhile, from a total of 1,661 tasks in Go Math! books from the United States, the Representation and Modelling category (A1) also dominates with 900 tasks (54.18%), most in Grade 1 in the Practice and Homework activity (61 tasks). The Calculation and Operations (A2) category came in second with 353 tasks

(21.25%), most in Grade 4 (68 tasks). The Interpretation category (A3) has 247 tasks (14.87%), the most in Grade 4 in Problem Solving-Applications (31 tasks). In contrast, the Argumentation and Reasoning category (A4) amounted to 163 tasks (9.81%), the most in Grade 4 in Math Talk (19 tasks). The following are examples of mathematical activities in geometry content analysed descriptively and presented in the form of Table 6.

Table 6. Categorisation of examples of mathematical activities in Indonesian and US mathematics books

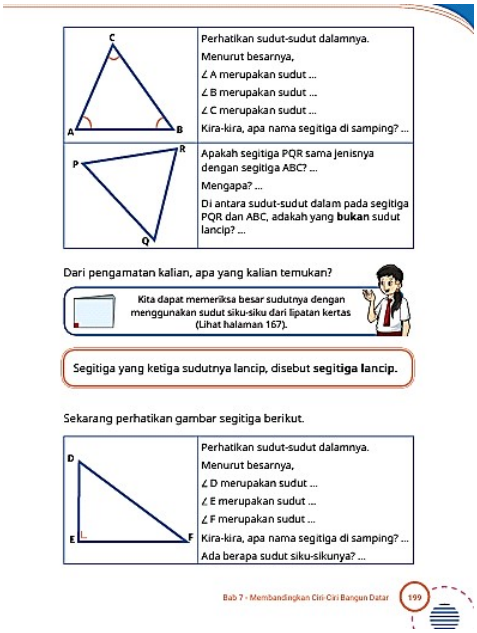
Representation & Modeling	
Indonesian Mathematics Textbook	Go Math! Book United States
	
Found in Grade 3 in learning activities "*Ayo Berlatih*" page 152.	Found in Grade 1 in learning activities, *Practice and Homework,* page 549.
Calculation & Operation	
Indonesian Mathematics Textbook	Go Math! Book United States
	
	Found in Grade 4 in learning activities, *Practice*

Found in Grade 5 in learning activities "*Ayo Membandingkan*" page 198.

and Homework, page 564.

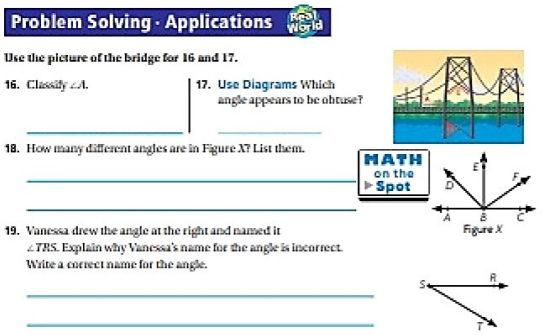
Interpretation

Indonesian Mathematics Textbook



Found in Grade 5 in learning activities "*Ayo Membandingkan*" page 199.

Go Math! Book United States



Found in Grade 4 in learning activities, *Problem Solving-Applications,* page 562.

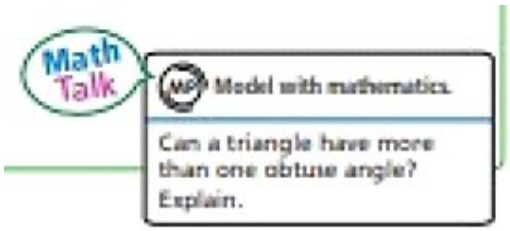
Argumentation and Reasoning

Indonesian Mathematics Textbook

10. Berdasarkan kegiatan tersebut, dapat kalian menyimpulkan, apakah jajargenjang itu?

Found in Grade IV in learning activities "*Ayo Beraktivitas*" page 158.

Go Math! Book United States



Found in Grade 4 in learning activities, *Math Talk* page 488.

Based on Table 6, while both textbooks emphasize representation and modelling, Go Math! incorporates more tasks involving argumentation and reasoning. This aligns with U.S. standards such as the Common Core, which promote mathematical communication and justification. These tasks foster students' ability to construct arguments, a key component of mathematical literacy (Umland, 2020). The US curriculum philosophy emphasizes that learning mathematics involves not only procedures but also the development of logical reasoning and the ability to explain thoughts explicitly. Therefore, the presence of argumentative problems in Go Math! reflects an effort to develop higher-order thinking skills and mathematical communication systematically.

However, the relatively low proportion of reasoning tasks in both books highlights the need for more deliberate integration of such activities

to cultivate critical thinking. In the Indonesian context, the "*Merdeka*" Curriculum emphasizes the importance of reasoning and argumentation competencies as part of the "*Pancasila*" Student Profile. However, the reflection of these principles in textbooks remains limited, indicating a gap between the curriculum document and its implementation at the teaching materials level.

Thus, the United States' Go Math! The book further encourages the development of conceptual understanding and critical thinking from an early age to develop higher-order thinking skills (HOTS), which are essential foundations for representing information in mathematical models (Nurharyanto & Retnawati, 2020). Understanding and critical thinking are essential aspects of mathematics learning, emphasizing not only calculation accuracy but also the ability to process information in depth. Critical thinking skills also contribute to better academic achievement and readiness for the next level of education (Purwaningsih & Wangid, 2021), while also equipping students to learn effectively and contribute creatively in future professions (Fitriyadi & Wuryandani, 2021).

Cognitive Complexity and Curriculum Expectations

The level of complexity in the textbook analysis is classified into three categories: Reproduction (L1), Connection (L2), and Reflection (L3). The details are in Figure 3.

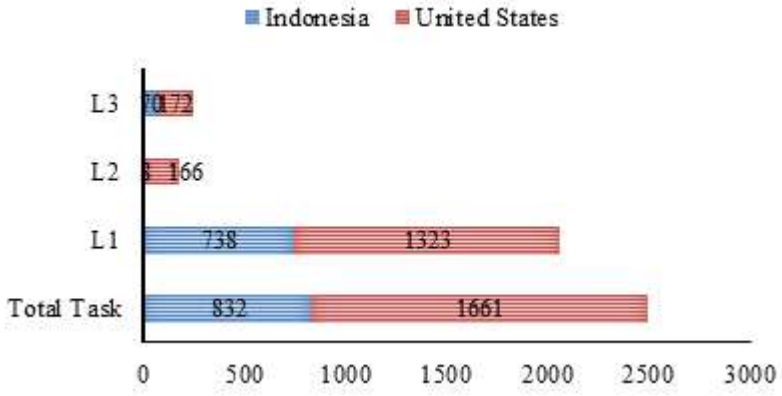
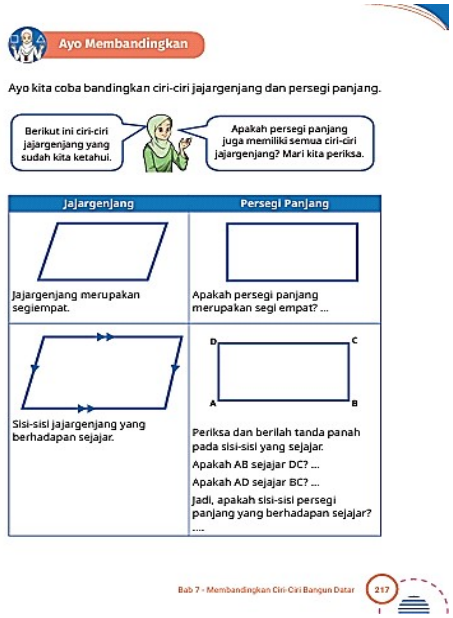
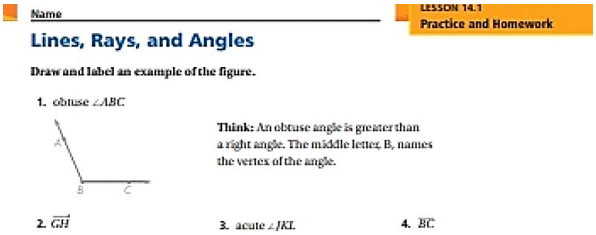
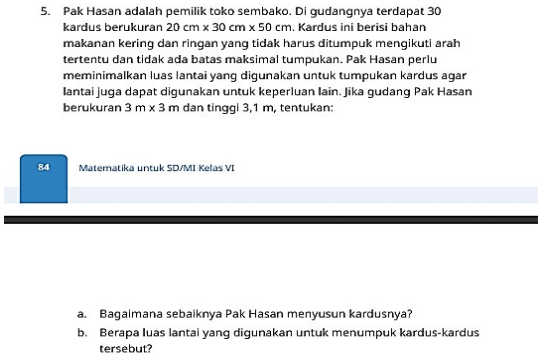
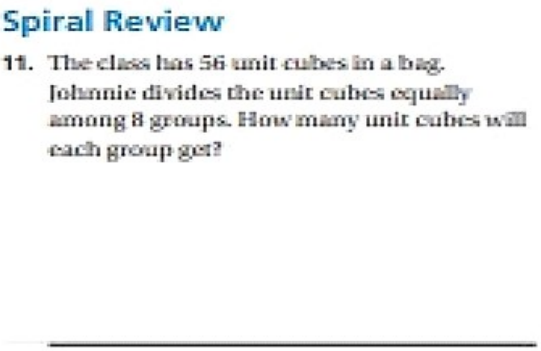
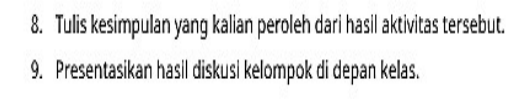
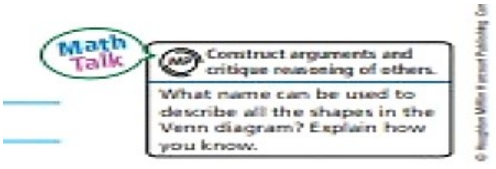


Figure 3. Categorisation of the complexity level of Indonesian and US books

Based on Figure 3, out of a total of 832 tasks in mathematics books for elementary schools in Indonesia, the Reproduction Level (L1) dominates with 738 tasks (88.70%), primarily found in Grade 5 in learning activities "*Ayo Membandingkan*" (105 tasks). The Reflection Level (L3) is in second place with 70 tasks (8.41%), mainly in Grade 4 in learning activities "*Ayo Beraktivitas*" (15 tasks). Meanwhile, the Connection Level (L2) is the lowest, with only eight tasks (0.96%), with the most distribution in Grade 6 in learning activities "*Ayo Mencoba*" (4 tasks).

Meanwhile, the Go Math! book from the United States, out of a total of 1,661 tasks, Level L1 also dominates with 1,323 tasks (79.65%), the most in Grade 4 in *Practice and Homework* (112 tasks). Level L3 amounted to 172 tasks (10.36%), mostly appearing in *the Math Talk* activity in Grade 4 (18 tasks). The L2 level amounted to 166 tasks (9.99%) and most often appeared in *Practice and Homework* in Grade 4, with 45 tasks. The following is an example of the level of complexity in geometry content analysed descriptively and presented in the form of Table 7.

Table 7. Categorisation of sample complexity levels of Indonesian and US mathematics books

Reproduction	
Indonesian Mathematics Textbook	Go Math! Book United States
	
Found in Grade 5 in learning activities "*Ayo Membandingkan*" page 217.	Found in Grade 4 in learning activities, *Practice and Homework* page 563.
Connection	
Indonesian Mathematics Textbook	Go Math! Book United States
	
Found in Grade 6 in learning activities "*Ayo Mencoba*" pages 84-85.	Found in Grade 4 in learning activities, *Practice and Homework* page 465.
Reflection	
Indonesian Mathematics Textbook	Go Math! Book United States
	
Found in Grade 4 in learning activities "*Ayo Beraktivitas*" page 106.	Found in Grade 4 in learning activities *Math Talk* page 578.

Based on Table 7, the dominance of direct application tasks (Level 1) in both textbooks reflects a tendency toward procedural instruction. Nevertheless, Go Math! includes a higher percentage of tasks at the Connection and Reflection levels, encouraging students to make links between concepts and apply knowledge in novel situations. This reflects the curriculum orientation in the United States, particularly in the Common Core State Standards (CCSS), which emphasizes the importance of deep conceptual understanding and adaptive thinking skills in facing real-world challenges.

The Indonesian textbook, by contrast, provides minimal opportunities for such engagement, potentially limiting students' development of flexible thinking skills. This indicates that although the "*Merdeka*" curriculum normatively emphasizes the development of reasoning and problem-solving competencies, in practice, as reflected in textbooks, this approach has not been fully implemented. The lack of questions at the connection and reflection levels can hinder the development of flexible thinking skills, which are essential for dealing with complex and non-routine situations.

Thus, the differences in the cognitive depth of questions in the two textbooks reflect differences in curriculum orientation: the US curriculum, which encourages conceptual integration and student adaptability, and the Indonesian curriculum, which, while progressive in vision, remains limited in its application to textbook learning materials.

Task Structure and Contextualization

The answer forms in the textbook analysis were classified into three categories: Open (J1), Closed (J2), and Multiple Choice (J3). The details are presented in Figure 4.

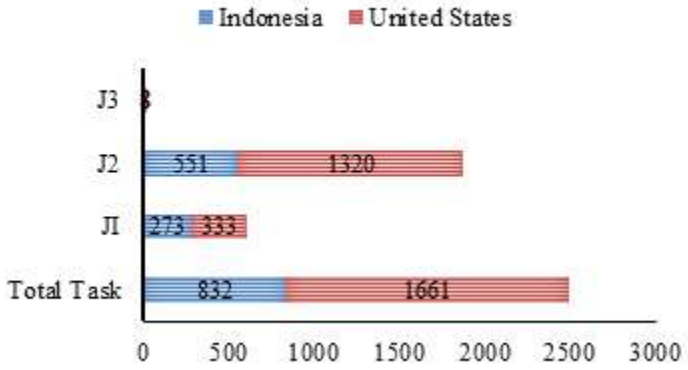


Figure 4. Categorisation of Indonesian and US book answer forms

Based on Figure 4, out of a total of 832 tasks in Mathematics books for elementary schools in Indonesia, the majority are in the form of Closed Answer (J2) total of 551 tasks (66.23%), primarily found in Grade 5 in learning activities "*Ayo Membandingkan*" (106 tasks). The Open Answer form (J1) amounted to 273 tasks (32.81%), mostly appearing in Grade 4 in learning activities "*Ayo Beraktivitas*" (60 tasks). Meanwhile, the Multiple Choice form (J3) is only found in 8 tasks (0.96%), with the highest distribution in class III in learning activities "*Ayo Berlatih*" (4 tasks).

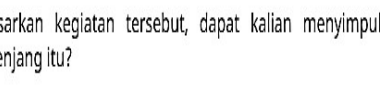
Meanwhile, Go Math! book from the United States are dominated by the Closed Answer (J2) form with 1320 tasks (79.47%), especially in Grade 4 in *Practice and Homework* (142 tasks). The Open Answer form (J1) amounted to 333 tasks (20.05%), mainly in *the Math Talk* activity in Grade 4 (21 tasks). Multiple Choice Form (J3) has very few, only eight tasks (0.48%), most appearing in Grade 4 in *Practice*

& Homework (3 tasks). The following are examples of answer forms in geometry content analysed descriptively and presented in the form of Table 8.

Table 8. Categorisation of example answer forms from Indonesian and US mathematics books

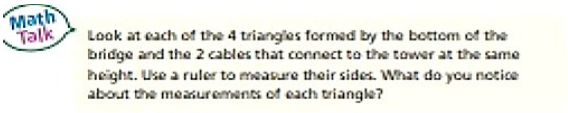
Open Answer

Indonesian Mathematics Textbook



Found in Grade 4 in learning activities "*Ayo Beraktivitas*" page 158.

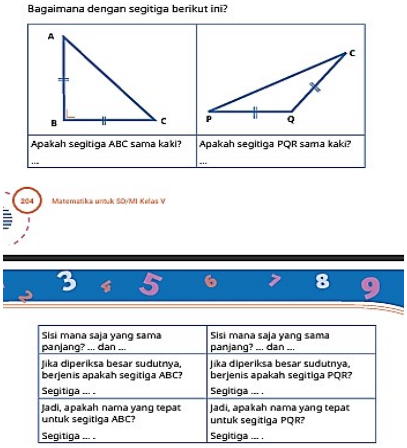
Go Math! Book United States



Found in Grade 4 in learning activities *Math Talk* page 556.

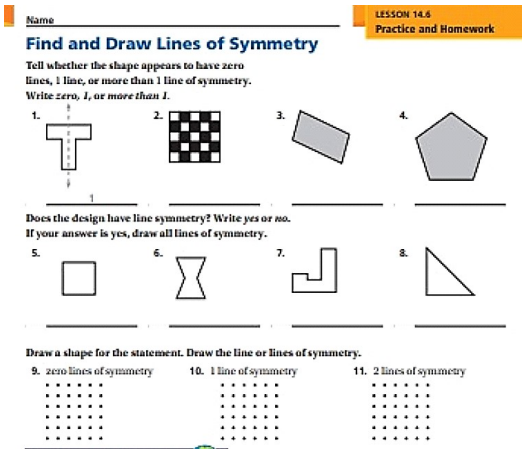
Close Answer

Indonesian Mathematics Textbook



Found in Grade 5 in learning activities "*Ayo Membandingkan*" page 204-205.

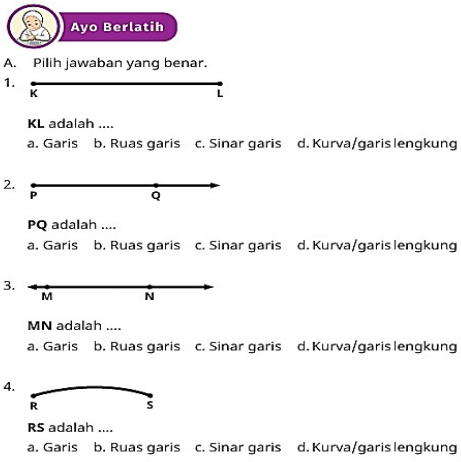
Go Math! Book United States



Found in Grade 4 in learning activities, *Practice and Homework* page 593.

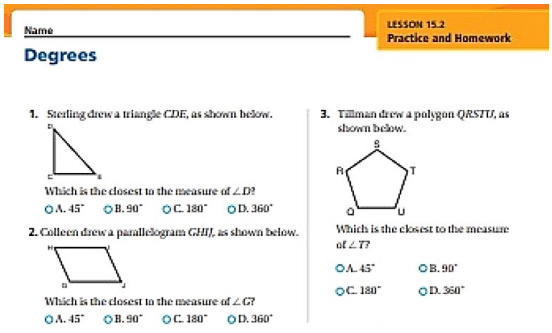
Multiple Choice

Indonesian Mathematics Textbook



Found in Grade 3 in learning activities "*Ayo Berlatih*" page 152.

Go Math! Book United States



Found in Grade 4 in learning activities, *Practice & Homework* page 619.

Contextual features in the textbook analysis are classified into three categories: Non-Application (C1), Realistic Application (C2), and Authentic Application (C3), with full details presented in Table 9.

Based on Table 9, out of a total of 832 tasks in mathematics books for elementary school in Indonesia, the majority are in the form of Non-Application (C1), totaling 631 tasks (75.84%), primarily found in Grade 5 in learning activities

Table 9. Categorisation of contextual features of Indonesian and US books

Aspect	Indonesia	Amerika Serikat
Total Task	832	1661
C1 (Non-Application)	631 (75.84%)	1465 (88.20%)
C2 (Realistic Application)	87 (10.64%)	180 (10.84%)
C3 (Authentic Application)	114 (13.70%)	16 (0.96%)

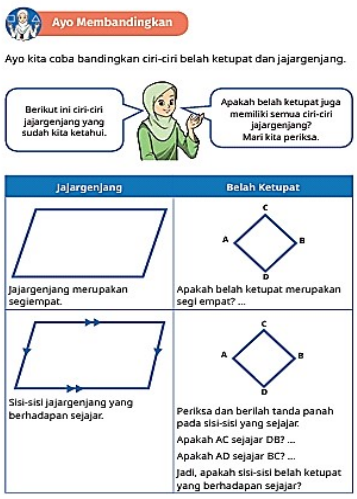
"*Ayo Membandingkan*" (112 tasks). Authentic Application Contextual Features (C3) amounted to 114 tasks (13.70%), mostly appearing in Grade 3 in learning activities "*Ayo Beraktivitas*" (37 tasks). Meanwhile, the Realistic Application Contextual Feature (C2) is only found in 87 tasks (10.64%), with the highest distribution in Grade 5 in learning activities "*Kompetensi*" (11 tasks).

Meanwhile, the Go Math! book from the United States is dominated by Non-Application Contextual Features (C1) as many as 1465 tasks (88.20%), especially in Grade 4 in *Practice and Homework* (118 tasks). Realistic Application Contextual Features (C2) amounted to 180 tasks (10.84%), mainly in *the Practice & Homework* activity in Grade 4 (41 tasks). Authentic Application Contextual Features (C3) are very few, only 16 tasks (0.96%), most appearing in Grade 4 in *Practice & Homework* (4 tasks). The following are examples of answer forms in geometry content analyzed descriptively and presented in the form of Table 10.

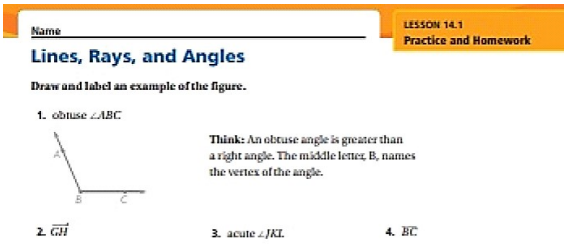
Table 10. Categorization of example answer forms from Indonesian and US mathematics books

Non-Application

Indonesian Mathematics Textbook



Go Math! Book United States

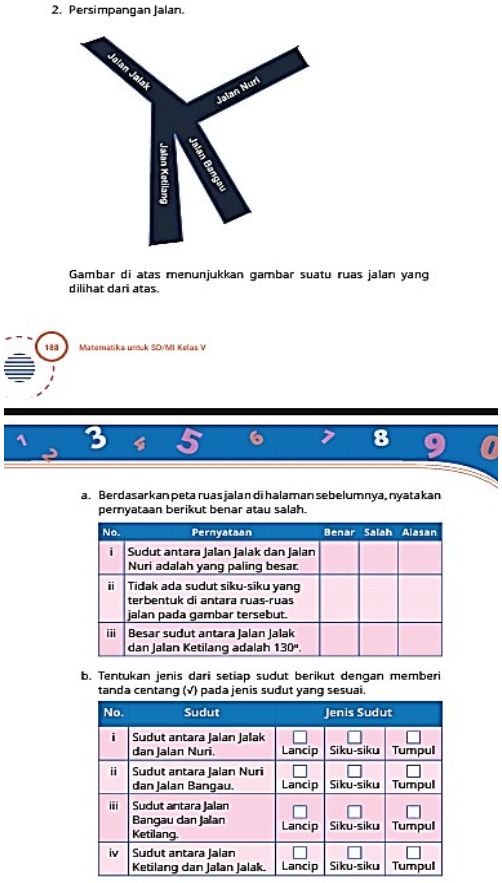


Found in Grade 4 in learning activities, *Practice & Homework* page 563.

Found in Grade 5 in learning activities "*Ayo Membandingkan*" page 221.

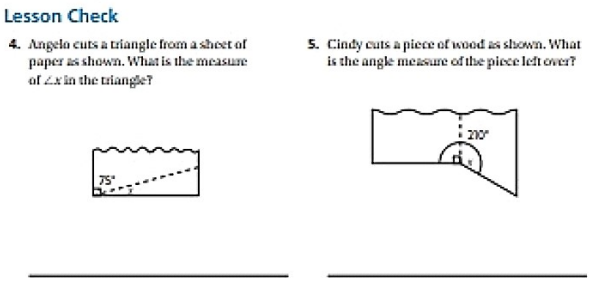
Realistic Application

Indonesian Mathematics Textbook



Found in Grade 5 in learning activities "*Uji Kompetensi*" page 189-190.

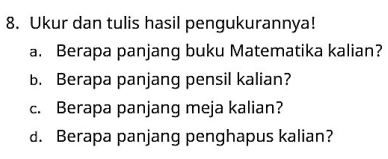
Go Math! Book United States



Found in Grade 4 in learning activities, *Practice and Homework* page 638.

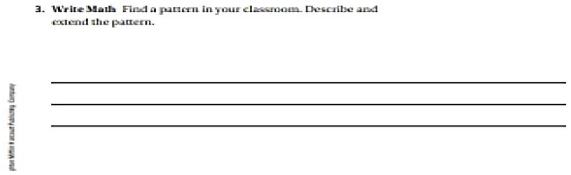
Authentic Application

Indonesian Mathematics Textbook



Found in Grade 3 in learning activities "*Ayo Beraktivitas*" page 151.

Go Math! Book United States



Found in Grade 4 in learning activities, *Practice & Homework* page 599.

Both textbooks heavily rely on closed-ended questions, which can restrict creativity and problem-solving strategies. Although Indonesian textbooks contain more open-ended and authentically contextualized tasks, these are not consistently distributed. Authentic applications are critical for helping students relate mathematics to real-world problems and for promoting

meaningful learning (Murti, 2023). The U.S. textbooks' emphasize on decontextualized tasks may hinder students' ability to see mathematics as relevant to everyday life.

Authentic applications in mathematics learning prepare students for real-world situations such as work and decision-making (Solehah & Setiawan, 2023). Students can connect the mathematical concepts to everyday life, realizing that mathematics is close to their environment (Triwahyuningtyas, Setiawan, & Mahmuda, 2022). The use of concrete media also increases the effectiveness of learning through active student involvement (Kristiani & Prasetyo, 2016). Contextual learning provides meaningful experiences and strengthens students' understanding (Murti, 2023).

Thus, Indonesian elementary school mathematics textbooks more consistently present contextual questions that reflect students' real-life situations, such as daily activities, social issues, and local contexts. This aligns with the principles of the "*Merdeka*" Curriculum, which emphasizes meaningful, contextual, and relevant learning.

In contrast, Go Math! textbooks from the United States tend to focus on procedural applications and realistic context-based problems (C2), with few or no authentic application problems (C3). This may be due to the US curriculum's orientation, which emphasizes basic skills acquisition, standardized test readiness, and procedural efficiency over direct relevance to students' local or social lives.

These findings reflect the philosophies applied in each country's curriculum. The Indonesian textbook aligns with the principles of the "*Merdeka*" Curriculum, which emphasizes meaningful and contextual learning, thus presenting more authentic application questions (C3). In contrast, Go Math! reflects the orientation of the US curriculum, which focuses on mastery of procedural skills and test readiness, resulting in a near-absence of authentic questions.

Furthermore, the analysis also shows that both textbooks are dominated by closed-ended questions, meaning questions with a single correct answer and a single solution. This can hinder the development of divergent thinking and student creativity. Although the Indonesian textbook contains more contextual questions, the dominance of closed-ended tasks in both textbooks indicates the need for a shift toward more open-ended questions to support 21st-century competencies.

Absence of Grade 6 Geometry in Go Math!

A notable limitation in the Go Math! series is the absence of explicit geometry content in Grade 6, which contrasts with international curriculum frameworks that advocate for continuous development of geometric understanding across all primary grades (NCTM, TIMSS). This gap raises concerns about students' readiness for secondary-level geometry, which requires a solid foundation in spatial reasoning and formal proof.

This absence reflects the structure of the Common Core State Standards (CCSS) upon which the Go Math! books were developed, where geometry content is emphasized in the early grades, while the focus shifts to reinforcing arithmetic and algebraic thinking in the upper grades. Although the CCSS emphasizes depth of understanding over breadth of coverage, this approach can lead to a reduced focus on developing spatial reasoning at a crucial stage in concept formation.

In contrast, the Indonesian "*Merdeka*" Curriculum maintains a more balanced distribution of geometry material across all levels in elementary school, including the upper grades. This aligns with the curriculum's philosophy, which emphasizes holistic, contextual, and continuous learning to develop students' reasoning skills and conceptual understanding comprehensively. Therefore, the difference in geometry material

coverage in Grade 6 between the two books reflects a fundamental difference in curriculum philosophy: one emphasizes procedural readiness and assessment outcomes, while the other emphasizes continuous concept development and contextual relevance.

■ CONCLUSION

This study analyzes the comparison of elementary school mathematics textbooks in Indonesia and the United States with a focus on geometry content. First, in terms of the form of mathematical content based on Van Hiele's theory, it was found that the Indonesian textbooks connect more geometric shapes and properties. However, both are dominated by content at the Analysis Level. Second, in terms of mathematical activities, the Go Math! textbooks are more prominent in argumentation and reasoning activities, but both books are equally dominated by Representation and Modeling activities. Third, in terms of complexity, the Go Math! textbooks demand more connections between concepts, although both are still dominant at the direct application level. Fourth, in terms of answer formats, both books are dominated by closed-ended questions.

Fifth, in terms of contextual features, the Indonesian textbooks present more authentic applications, although both contain more non-applicative problems. Another important finding is the absence of geometry material in Grade 6 in the Go Math! textbooks (2023 Edition), which contradict international standards such as NCTM and TIMSS, which emphasize the continuous development of geometric understanding. This absence has the potential to hinder students' readiness to face advanced geometry, including the concepts of transformation, congruence, and formal proof. Thus, a notable difference between the two textbooks is that the Indonesian textbook places greater emphasis on the relationship between geometric shapes and properties and authentic applications, while Go Math! is stronger in argumentation and reasoning activities but shows a significant gap in the omission of geometry material in Grade 6, potentially hindering students' readiness to understand advanced geometry.

Some implications that can be considered include: informal deduction in geometry content should be utilized by teachers to strengthen students' reasoning and become the basis for developing an understanding-based curriculum; the distribution of mathematical activities in textbooks needs to be more even between representation, calculation, interpretation, and argumentation to deepen conceptual understanding; the proportion of complexity levels should be more balanced with an emphasis on developing HOTS; open-ended questions need to be increased to encourage critical and creative competencies; and contextual features based on authentic applications need to be improved in preparing students for real-world situations. Textbook developers in Indonesia are expected to balance procedures and conceptual reasoning more effectively to develop meaningful understanding, while teachers need to take an active role in complementing and enriching textbook material with relevant, challenging, and applicable activities.

This research was conducted from December 2024 to May 2025, with in-depth and iterative data analysis to obtain valid findings. Book revisions after that period were not included in the scope of the study. This research was limited to analyzing the geometry content in Indonesian elementary school mathematics textbooks and Go Math! textbooks from the United States, using the Gracins' framework (2018), which encompasses five aspects: Mathematical Content, Mathematical Activity, Complexity Level, Answer Form, and Context. Mathematical content was analyzed based on Van Hiele's levels of thinking (levels 1–5), so the study results only provide a comparison of the two book series on geometry topics. The findings in

this study cannot be generalized to all countries or all mathematics textbooks due to the limited scope of the analysis. Further research is recommended to analyze all mathematics content comprehensively using the Gracins' framework, which can be integrated with Van Hiele's theory for a more comprehensive understanding. In addition, future research can expand the scope of the space by comparing textbooks from other mathematics domains, examining across educational levels, or discussing the analysis of textbooks with student learning outcomes empirically to understand their direct impact on students' mathematics competencies.

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