



Comparison of Vector Tasks in Indonesian and Singaporean Mathematics Textbooks

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Abstract

Vector is one of the most important subjects in mathematics, but many students face difficulties in learning vector. To find out the cause, this study is conducted to find the differences and similarities in learning opportunities presented in the vector tasks from Indonesian and Singaporean mathematics textbooks. Therefore, vector tasks from the two books are compared with the aspects of representations, contextuality, and response types. Firstly, this study finds out that the chosen Indonesian textbook provides fewer learning opportunities than the chosen Singaporean textbook in terms of vector tasks. Secondly, this study also finds out that the Indonesian textbook tends to present tasks in visual representation, while the Singaporean textbook tends to present tasks in pure mathematics form. Thirdly, this study also finds out that Indonesian textbook usually uses applicative tasks that correlate with real-life situations, while the Singaporean textbook does the otherwise. Lastly, this study also finds out that both textbooks mostly use close-ended tasks.

Keywords: vector, mathematics textbooks, comparison

1. Introduction

In the 21st century, the problems that arise in daily life become harder and more complicated to solve (Rizki & Priatna, 2019). To seek a holistic approach to redesigning curriculum for 21st century education, Bialik & Kabbach (2014) made a framework with four dimensions of 21st century education, consisting of (1) knowledge, (2) skills, (3) character, and (4) metacognition. The skills needed in the 21st century are creativity, critical thinking, problem-solving skills, collaboration skills, technology skills, and various literacy skills such as social, cultural, and metacognitive (Care, 2018). By learning mathematics, it is possible to give students opportunities to train their strategic competence collaboratively with their mathematics reasoning skills which could increase students' 21st-century skills (Whitney-Smith, 2022).

To prepare students to face the 21st century, a new way to educate mathematics is required (Gravemeijer, 2014). In the preparation stage in education, curriculum resources are the main key that could be customized with the expected learning. (Pepin & Gueudet, 2020) state that curriculum resources include (1) text resources (textbooks, teacher's guidebooks, website, syllabus, and test), (2) other material resources (manipulative objects and calculator), and (3) digital curriculum resources (interactive e-book).

The problem that arises in increasing the quality of learning is the lack of understanding from teachers and parents in choosing the right learning media to support students' learning process, such as textbooks (Nuryati et al., 2023). On the other hand, the usage of textbooks could maximize the learning process in schools consequently making the quality control of textbooks' contents taken into account (Maaliki H et al., 2020). Textbooks play a significant role in every school system around the world. That is to transfer the useful resources to teachers as the course designer and the useful knowledge for students (Torkar et al., 2022). In mathematics textbooks, mathematics tasks are one of the most important aspects to increase students' abilities moreover if the tasks are diverse (Hwang & Ham, 2021).

Vector is one of the principal knowledge that students in STEM majors need to have, especially for courses such as linear algebra or vector calculus. Linear algebra and calculus are courses needed for STEM major students, but from the subjective report from mathematicians who teach linear algebra and do research studies, it was found that students had difficulties with linear algebra (Harel, 2017). Raj Acharya (2017) stated that the leading factors of students' difficulties are mathematics anxiety, students' prior knowledge, and students' efforts in learning mathematics. Students' prior knowledge is related to the knowledge that they have learned before. In line with students' prior knowledge essence as the leading factor that causes students difficulties in linear algebra, most of the senior high school students faced misconceptions in solving vector tasks (Utami & Mukhni, 2021). To tackle this problem, Junaeti et al. (2023) suggested engaging students with complex content and various problem-solving tasks to enhance students' conceptual understanding in vector.

To search for learning opportunities presented in textbook vector tasks, this study will conduct a document analysis to see the similarities and differences between Indonesian mathematics textbooks and Singaporean mathematics textbooks. Singapore is chosen as the comparator due to its excellent performance in PISA 2022 and TIMSS 2019. Singapore is ranked first for mathematics in PISA 2022 with a score of 575 which is higher than the world's average (OECD, 2023). In TIMSS 2019, Singapore is also ranked first for 4th grade and 8th mathematics with each grade scoring 625 and 616 (Mullis et al., 2020). Therefore, we are interested in using Singapore as the comparator due to its excellent quality of mathematics education.

Several studies have compared Indonesian mathematics textbooks with Singaporean mathematics textbooks. In the previous study, the comparisons that were done included mathematics topics, such as trigonometry (Yang & Sianturi, 2017), probability (Yang & Sianturi, 2019), linear equation

with one variable (Julia et al., 2022), linear equation systems with two variables (Kaerudin et al., 2023), fraction (Purnomo et al., 2023), sets (Hendriyanto et al., 2023), and angles (Purnomo et al., 2024). In this study, we are going to compare vector tasks in senior high school mathematics textbooks.

There are three dimensions to be noted in doing mathematics textbook tasks comparison, they are (1) representation forms, (2) contextual features, and (3) response types (Yang et al., 2017). Representation forms are the forms used in making mathematics tasks, these forms include purely mathematical form, verbal form, visual form, and combined form. Contextual features are the features regarding the context used in the tasks, whether it is applicable in the real world or not. Lastly, response types discuss the number of correct responses from one task (open-ended or close-ended).

Technology also plays an important role in enhancing students' learning opportunities. This is caused by the newer generation's favor in using technology to interact using technology and alter the way of teaching (Dineva et al., 2019). This change leads to a newer environment for learning such as mobile technology, digital learning objects, and other tools that are related to the classroom learning (Engelbrecht et al., 2020). The integration of technology and task design can affect students' learning in a meaningful and positive way (Bray & Tangney, 2017). Therefore, this study is going (1) to look for the general overview of learning opportunities presented in the vector tasks from the chosen Indonesian and Singaporean mathematics textbooks and (2) to look for the similarities and differences between the chosen Indonesian and Singaporean mathematics textbooks regarding their representation forms, contextual features, response types, and the technology usage in the vector tasks.

2. Methods

This study uses a qualitative document analysis approach. Qualitative research is research that seeks to find the quality of relationships, activities, situations, and other material (Fadli, 2021). Meanwhile, document analysis consists of analyzing various types of documents such as textbooks (Morgan, 2022). This study will conduct a document analysis to see the differences and similarities between Indonesian and Singaporean learning opportunities regarding vector tasks.

2.1. Textbooks Selection

Indonesia's Matematika Kelas X SMA/SMK that is written by Susanto et al. (2021) is chosen as the mathematics textbook that represents Indonesia. The book was published by Pusat Kurikulum dan Perbukuan which is available at <https://buku.kemdikbud.go.id/katalog/matematika-untuk-smasmk-kelas-x>. The book is free and provided by the Indonesian government. The book has also been integrated with the recent curriculum which is Kurikulum Merdeka.

New Syllabus Mathematics 7th Edition from Yeo et al. (2016) is chosen for the Singaporean mathematics textbook. The book is considered a good comparator because New Syllabus Mathematics has been selected for the previous study conducted by Yang & Sianturi (2017, 2019) and (Hendriyanto et al., 2023). The book was published by Shing Lee Publisher and included learning experiences from the investigation, class discussion, thinking time, journal writing, and performance task activities.

2.2. Analytical Framework

The analytical framework used in this textbook comparison is taken from the previous study done by Yang et al. (2017) with the addition of technology usage in the tasks. The framework includes four dimensions which are representation forms, contextual features, response types, and technology usage (Table 1). The present study defined mathematics tasks as activities, homework, and exercises related to the vector. The worked examples and reflections from the textbooks won't be counted in this study.

To analyze the problems, the problems will be encoded following the framework. If the problem has several sub-questions, each sub-questions will be counted as one problem. If the problem is written in one sentence and has several orders related to the steps/completeness in solving the problem, the problem will be counted as one problem. Meanwhile, if the problem is written in one sentence and has several orders that are not related to one another, every order will be counted as one problem.

Table 1

Textbook's comparison analytical framework

Dimension	Categories
Representation forms	Purely mathematical forms Verbal forms Visual forms Combined forms
Contextual features	Correlated with real-world Not correlated with real-world
Response types	Open-ended Close-ended
Technology usage	Using technology Not using technology

Table 2

Problems inclusion examples

Problem	Inclusion
Can you give two examples of parallel vectors related to daily life? (Susanto et al., 2021:69)	The problem will be counted as two problems since the process of giving the first example are not related to the process of giving the second example.
Draw a car speed vector with a velocity of 60km/h and it goes to the east. Determine its starting point and ending point. Write the vector's name and its scale. (Susanto et al., 2021:69)	The problem is counted as one problem since the order to determine the starting and ending point, give the name, and write its scale are parts of the order to draw the car's vector.
Draw the position vectors from vector $OP = 2i + 2j - 2k$ and vector $OQ = i + 2j - k$. (Susanto et al., 2021:79)	The problem is counted as one problem since students need to draw two distinct vectors that are not related to one another.

3. Result and Discussion

3.1. General Overview

From this study, there are 116 tasks found in the Indonesian mathematics textbook and there are 489 tasks found in the Singaporean mathematics textbook. The vector chapter in the Indonesian mathematics textbook consists of 33 pages (61-94) with subchapters about terminology, vector notation, and vector types; vector and the coordinate system; and vector operations. Meanwhile, the Singaporean mathematics textbook provides 57 pages (163-220) for the vector chapter with subchapters like vectors in two dimensions, vector addition, vector subtraction, scalar multiples of a vector, position vectors, and application of vectors. Although there is a big difference in the subchapters' naming, there are not that many differences regarding the content types presented to students.

From the general overview, it was found that the learning opportunities presented in the Indonesian mathematics textbook are far fewer than the learning opportunities presented in the Singaporean textbooks. Both the chapter pages and the number of vector tasks from the Singaporean mathematics textbook exceed the Indonesian mathematics textbook. The constitution of the Indonesian mathematics textbook has a bad influence on students with high motivation as there is an indirect influence between task-giving intensity and students' achievement through learning motivation (Sari & Wahjudi, 2021). This problem can be one of the reasons why Indonesian students' mathematics scores are lower than Singaporean students. Therefore, it would be better for Indonesian mathematics textbooks to create more learning opportunities.

3.2. Representation Forms

After encoding both of the books, it was found that the Indonesian mathematics textbook focuses more on visual form tasks and the Singaporean mathematics textbook focuses more on purely mathematical form tasks. The Indonesian mathematics textbook consists of 17 purely mathematical form tasks (14.7%), 42 verbal form tasks (36.2%), 56 visual form tasks (48.3%), and 1 combined form tasks (0.9%). The Singaporean mathematics textbook consists of 199 purely mathematical form tasks (40.7%), 5 verbal form tasks (1.0%), 149 visual form tasks (30.5%), and 136 combined form tasks (27.8%). From the distribution, it was found that the Indonesian mathematics textbook rarely uses combined form tasks. On the contrary, Singaporean mathematics textbook rarely uses verbal form tasks. The usage of verbal, visual, and combined form tasks helps students to train their information-gathering skills as they need to translate the picture/sentence into a mathematics equation. Although the Singaporean mathematics textbook mostly uses purely mathematical form tasks, the number of combined form tasks is still higher than the number of tasks in the Indonesian mathematics textbook. This resulted in higher learning opportunities for Singaporean students to train for their information-gathering skills since the number of their verbal, visual, and combined form tasks is higher than the Indonesian mathematics textbook.

The finding of the Singaporean mathematics textbook is similar to the one Julia et al. (2022) found, but it is different from the one that Yang et al. (2017) found. Yang et al. (2017) found that Singaporean mathematics textbooks mostly use visual forms in geometry tasks. Meanwhile, the finding of the Indonesian mathematics textbook is different from Julia et al. (2022) finding, they found that Indonesian mathematics textbooks often use purely mathematical form tasks in linear equation systems of two variables. One of the possibilities that lead to this difference is the reason that every chapter in textbooks has its own representation forms distribution and there is no general distribution. It would be better for the Indonesian mathematics textbook to increase the number of combined form tasks and it would be better for the Singaporean mathematics textbook to increase the number of verbal form tasks and reduce the number of purely mathematical form tasks.

Table 3

Distribution of vector tasks representation forms

Representation forms	Indonesia		Singapore	
	n	%	n	%
Purely mathematical	17	14.7%	199	40.7%
Verbal	42	36.2%	5	1.0%
Visual	56	48.3%	149	30.5%
Combined	1	0.9%	136	27.8%
Total	116	100%	489	100%

3.3. Contextual Features

After encoding both of the books, it was found that the Indonesian mathematics textbook uses more tasks that correlate with real-world situations, unlike the Singaporean mathematics textbook which barely uses it. The Indonesian mathematics textbook consists of 78 correlated with real-world tasks (67.2%) and 38 not correlated with real-world tasks (32.8%). On the contrary, the Singaporean mathematics textbook consists of 7 correlated with real-world tasks (1.4%) and 482 not correlated with real-world tasks (98.6%). This finding highly correlates with the previous finding in representation forms, since the Singaporean mathematics textbook mostly uses purely mathematical forms, it resulted in a high number of not correlated with real-world tasks. From the contextual features dimension, the Indonesian mathematics textbook serves as a better learning opportunity to train students to solve problems that correlate with the real world than the Singaporean mathematics textbook.

On the contextual features, the finding of the Indonesian mathematics textbook uses more tasks that correlate with the real world differs from Wijaya et al. (2015) and Hidayah & Forgasz (2020) findings. Both Wijaya et al. (2015) and Hidayah & Forgasz (2020) found that the Indonesian mathematics textbook's tasks mostly are not contextual. Meanwhile, the finding of the Singaporean mathematics textbook rarely uses tasks that correlate with the real world is similar to Yang et al. (2017) findings although in this finding, the proportion correlated with real-world tasks is smaller than the one Yang et al. found. It would be better for the Singaporean mathematics textbook to increase the number of contextual tasks.

Table 4

Distribution of vector tasks contextual features

Contextual features	Indonesia		Singapore	
	n	%	n	%
Correlated with real-world	78	67.2%	7	1.4%
Not correlated with real-world	38	32.8%	482	98.6%
Total	116	100%	489	100%

3.4. Response Types

After encoding both of the books, it was found that both the Indonesian mathematics textbook and the Singaporean mathematics textbook tend to use close-ended tasks. The Indonesian mathematics textbook consists of 93 close-ended tasks (80.2%) and 23 open-ended tasks (19.8%). Meanwhile, the Singaporean mathematics textbook consists of 422 close-ended tasks (86.3%) and 67 open-ended tasks (13.7%).

On the response types, the finding of the Indonesian mathematics textbook tends to use close-ended tasks is similar to Hidayah & Forgasz (2020) finding although the percentage of the open-ended

tasks is higher in this finding. On the other hand, the finding of the Singaporean mathematics textbook tends to use close-ended tasks is also similar to Yang et al. (2017) finding with a very similar distribution percentage. Therefore, it would be better for both books to give more open-ended tasks to students as they serve as a better learning opportunity.

Table 5

Distribution of vector tasks response types

Response types	Indonesia		Singapore	
	n	%	n	%
Close-ended	93	80.2%	422	86.3%
Open-ended	23	19.8%	67	13.7%
Total	116	100%	489	100%

3.5. Technology Usage

After encoding both of the books, it was found that neither the Indonesian mathematics textbook nor the Singaporean mathematics textbook integrated technology with the vector tasks. They only presented that there are certain technologies that can be used in learning vector, but they don't integrate any of the vector tasks using technology.

On technology usage, the finding of the Indonesian mathematics textbook and Singaporean mathematics textbook rarely use technology-integrated tasks is similar to Julia et al. (2022) finding although the percentage of technology-integrated tasks is zero in this finding. Therefore, it would be better for both books to give more tasks that are integrated with technology to further enhance students' learning opportunities.

4. Conclusion

From this study, it was found that the chosen Indonesian mathematics textbook and the chosen Singaporean mathematics textbook differ in so many aspects. The number of vector tasks in the Indonesian mathematics textbook is far fewer than in the Singaporean mathematics textbook and this resulted in less learning opportunities presented in the Indonesian mathematics textbook. The Indonesian mathematics textbook uses a lot of visual form tasks, correlated with real-world tasks, and close-ended tasks. Meanwhile, the Singaporean mathematics textbook uses a lot of purely mathematical form tasks, not correlated with real-world tasks and close-ended tasks. In the future, the Indonesian mathematics textbook should present more vector open-ended and combined form tasks. Meanwhile, the Singaporean mathematics textbook should reduce the number of purely mathematical forms and give more open-ended contextual vector tasks.

Since this study only used one book to represent each country, there is lack of generality from the study presented. For further research regarding learning opportunities in vector tasks, researchers

can contrast different aspects such as taxonomy bloom and add more books/countries to further see the effects and difference between learning opportunities towards students' learning experience.

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