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A Comparative Analysis of the Tasks from the Selected Mathematics Textbooks of Singapore and Indonesia

Varetha Lisarani, I Nengah Parta, Tjang Daniel Chandra
Mathematics Education–Universitas Negeri Malang
Jl. Semarang 5 Malang, Indonesia 65145. E-mail: varetha.lisarani.1603118@students.um.ac.id

Abstract: This is a content analysis study that aims to analyze the tasks in Pythagorean Theorem unit contained in Indonesian mathematics textbooks and compare them to those of Singapore using the framework to analyze tasks in the textbook with three dimensions of analysis: representation form, contextual feature, and degree of openness. The result of the study shows that in Singaporean Mathematics textbook, verbal representation tasks and closed-ended tasks are commonly found throughout the textbook, meanwhile, application and non-application tasks are divided into exactly a half. In Indonesian Mathematics textbook, combination tasks, non-application tasks, and open-middled tasks are the most common tasks found.

Key Words: task, mathematics textbook, pythagorean theorem

Abstrak: Penelitian ini merupakan analisis konten yang bertujuan untuk menganalisis tugas yang termuat dalam buku teks matematika Indonesia untuk kemudian dibandingkan dengan tugas-tugas pada buku teks matematika Singapura menggunakan kerangka kerja untuk menganalisis tugas pada buku teks yang memuat tiga dimensi analisis yaitu bentuk representasi, fitur kontekstual, dan derajat keterbukaan. Hasil penelitian menunjukkan bahwa pada buku teks matematika Singapura, tugas dengan representasi verbal dan tugas tertutup adalah jenis yang paling banyak muncul, sedangkan tugas aplikasi dan non-aplikasi terbagi tepat menjadi dua. Pada buku teks matematika Indonesia, tugas dengan kombinasi representasi, tugas non-aplikasi, dan tugas *open-middled* adalah jenis yang paling sering muncul.

Kata kunci: tugas, buku teks matematika, teori pitagoras

INTRODUCTION

Following the change of Indonesian Curriculum in 2013, the government has released textbooks that are designed based on scientific approach and authentic assessment for each grade which intended to be applied nationally. However, these textbooks are still lacking in many areas, and few researchers have been suggesting revisions such as composing the material in the textbook sequentially, correcting the diction used in the textbook hence the content can be understood easier, synchronizing students' and teachers' book, using sentences effectively, adding more examples and exercises, correcting typos, and adjusting the difficulty level of the tasks in the textbook (Muklis, 2015; Widyaharti, et al., 2015; Retnawati, 2013; Krisdiana, et al., 2013; Ningsih, 2014; Fajriatin, 2015).

Textbooks are an integral part of teaching and learning because they are a reflection of the curriculum applied (Özer & Sezer, 2014). Textbooks are the best source for providing learning opportunities, and how students construct a mathematical idea will be influenced by the ways in which mathematics is structured and presented in the textbook (Sutherland, 2017). The importance of textbooks resulting in an increase in the number of studies focusing on textbook analyses (Özer & Sezer, 2014). Ones of such studies are comparative studies of tasks presented in the textbook. The results of such studies will provide some explanations of the performance differences in the international comparative studies such as PISA, provide one point of view about the kind of learning opportunities students are given in different countries, and they will help in the writing of mathematics text-

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books that are up to par in the future (Cai, et al., 2002; Özer & Sezer, 2014).

In this paper, a framework to analyze tasks in the textbook is used to compare of the tasks contained in Indonesian mathematics textbooks and compare them to those of Singaporean, that score the highest in a global comparison of mathematics performance according to PISA 2015's result (OECD, 2016). Another reason Singaporean Textbook is chosen is because the country applied a national curriculum, which is considered as a factor why students in this country consistently outperforming students in the US according to Carlin (2009). This study is limited only in the Pythagorean Theorem unit since the theorem frequently appears in PISA and is also useful in real-world problems (OECD, 2013).

METHOD

This was a content analysis research which aims to obtain descriptive information about the tasks in mathematics textbooks used in Indonesia and Singapore using the framework to analyze tasks in the textbook. The data in this study were the tasks in selected textbooks from Singapore and Indonesia. Singapore was chosen as a comparator of Indonesia since the country ranks the highest in mathematics performance among PISA 2015 participants, with a mean score of 564 (OECD, 2016), and similar to Indonesia, this country applied a national curriculum, which is considered as a factor why students in Singapore consistently outperforming students in the US according to Carlin (2009).

Buku Siswa Matematika (BSM) was chosen as a representative mathematics textbook of Indonesia since it is distributed by the government as the mandatory textbook which is distributed national-wide in the country. New Syllabus Mathematics (NSM) was chosen as the representative textbook from Singapore because it is one of the approved textbooks by the Ministry of Education (MoE) and it has the highest market share in Singapore. The tasks to be studied are tasks under the headers of 'Exercise', 'Practise Now', and 'Challenge Yourself' in NSM, and under the '*Ayo Kita Berlatih*', '*Uji Kompetensi*', and '*Ayo Kita Menalar*' headers in BSM textbook, which have no accompanying solutions or answer presented.

Table 1. Framework to Analyze Tasks in Textbook

1.	Representation Form	• Purely mathematical form (PM) • Verbal form (VE) • Visual form (VI) • Combined form (CO)
2.	Contextual Feature	• Application task (AP) • Non-application task (NAP)
3.	Degree of Openness	• Closed task (CL) • Open-middle task (OM) • Open-ended task (OE)

The tasks from both textbooks were analyzed using a framework to analyze tasks in the textbook as shown in Table 1. The tasks are coded by two coders using the framework, then the coding will be tested for the reliability. If the reliability reaches 90%, then the coding result will be used to organize the task and to arrive at a narrative description of the finding.

RESULTS

The result of the coding is presented in Table 2 below. There is a total of 62 tasks in NSM and 75 in BSM. For the Representation Form, the verbal form is the major representation form used in tasks of NSM with the percentage of 46.77%, followed narrowly by combination form with 45.16%, and then by visual form by 8.06% and no pure mathematics representation form found in the Pythagorean Theorem unit in the textbook. The contextual feature for NSM divided fairly as a percentage of both application tasks and non-application tasks are 50%. The degree of openness of the tasks in NSM majorly tends to closed tasks with the percentage of 62.9%, only 37.1% tasks are open-middle tasks, and no open-ended tasks found throughout the unit in this textbook.

For BSM, the majorly used representation form is combination form with the percentage of 40%, followed by verbal form with 38.67%, visual form with 21.33, and similar to NSM, no purely mathematics

Table 2. Coding Results

Title of the book	Number of Tasks	Representation form				Contextual Feature		Degree of Openness		
		PM	VE	VI	CO	AP	NAP	CL	OM	OE
NSM	62	0	46.77	8.06	45.16	50	50	62.9	37.1	0
BSM	75	0	38.67	21.33	40	14.67	85.33	45.33	49.33	5.33

All data are presented in percentage (%)

representation form found throughout the unit. For the dimension of Contextual Feature, only 14.67% tasks are found to be application tasks, and the rest of 85.33% are non-application tasks. Majority tasks in the Pythagorean Theorem unit of BSM are found to be open-middled tasks with the percentage of 49.33%, followed by closed tasks with 45.33%. Different from NSM, open-ended tasks are found in the BSM even with an only small percentage (5.33%).

DISCUSSION

Comparison of Representation Form of Tasks in NSM and BSM

Based on the result, we see that there is no task of Pythagorean Theorem unit of both NSM and BSM that presented in purely mathematics form. This is an implication of the nature of Pythagorean Theorem that closely related to a right triangle—a geometrical figure—which makes it difficult to make tasks that only consists of mathematics form (Sparks, 2008; Yang, 2016)). The tasks of both countries use either the verbal form where they describe the situation and/or the figure, visual form where the figure is explicitly attached, or the combination of both; these findings are in line with those of Yang's (2017). Yang explained that the using of various representations provide students with opportunity to solve various types of problems involving more than one representation, and it will also help students in understanding the concept of Pythagorean Theorem and it relationships with given geometrical figures and/or real-world situations, and even it will develop students' ability for problem-solving in geometry (National Council of Teacher of Mathematics, 2000; Widjaja, 2013; Yang, 2017).

In both NSM and BSM, the combined representation form tasks can be divided into two types: application tasks in form of word problems and also non-application tasks where visual representations given to students besides the verbal representation to help them visualizing the condition depicted by the tasks. According to the National Council of Teachers of Mathematics (2000), such using of combined representation form in textbooks is recommended since it will encourage students to be accustomed to use many forms of representation.

One of the differences of both countries is the fact that the tasks of Pythagorean Theorem unit in NSM are majorly presented in verbal representation form (46.77%), where the situation and/or the figure are being described in words, and the combination of visual and verbal form (45.16%) is followed after without any significant difference. Meanwhile, the tasks in BSM are majorly presented in combination form (40%), followed by verbal representation form (38.67%) with a narrow difference. Since NSM uses verbal representations the most, it utilizes representation as a medium to communicate mathematical approach, arguments, and understandings in words. Meanwhile, since BSM uses a combined form of representation the most, it focuses more on helping students to understand the mathematical concept (in this case, the Pythagorean Theorem) and its relationship, also to make connections between Pythagorean Theorem and other relevant mathematical concepts (National Council of Teacher of Mathematics, 2000).

The visual representation is not the commonly used representation of tasks in both NSM and BSM. Both Pythagorean Theorem tasks in BSM and NSM are presenting geometrical figures and then students are being asked to find the unknown(s). However, NSM only presents five tasks in pure visual form meanwhile BSM presents up to 16 of such task. All five pure visual form tasks in NSM inquire students to find the unknown(s) given the illustration of the triangle and the combinations of geometrical figures, meanwhile, such tasks in BSM does not only cover that but also cover topics such as the distance of two points in Cartesian coordinates. A similar condition also can be found when comparing verbal representation form tasks of both countries. In NSM, the verbal representation form tasks are only divided into two types: 1) application tasks in form of the word problem, and 2) tasks describing right triangles' (or combination of geometrical figures') features and then students are asked to find the unknowns. Meanwhile, other than the two types, verbal representation tasks in BSM also included: 1) tasks where students are encouraged to give opinion on the using of Pythagorean Theorem in various three-dimensional figures, 2) tasks where students are given an illustration of two characters answering question-related to Pythagorean Theorem and then students are asked their opinion on why both characters have different right answers, 3) tasks where students are asked to give reason why a given formula to find Pythagorean Triplets only works under certain condition, 4) tasks where students are asked to find a complete Pythagorean Theorem given only two or even one of the member.

Comparison of Contextual Feature of Tasks in NSM and BSM

Based on the comparative study of geometry tasks in middle-grade mathematics textbooks conducted by Yang (2017), Singaporean emphases more on non-application tasks (86.2%) rather than application tasks (13.8%). This is, in fact, not the case in this study. The contextual feature of Pythagorean Theorem tasks in NSM as a representative mathematics textbook of Singapore are exactly divided in half (50:50) into the application and non-application task. This shows that students in Singapore have a common exposure to tasks presented in the context of the real-world situation. It explains why students in Singapore perform greatly in international assessments such as PISA (OECD, 2016), which frequently use real-world context in its items. Meanwhile, one possible reason students in Indonesia perform poorly in PISA is because students in the country rarely have opportunities to solve problems in real-world context, because lack of exposure to real-world situation tasks may lead to students' difficulties in solving such tasks (Yang, 2017), and we see that BSM as a representative mathematics textbook from Indonesia only presents 14.67% application tasks, meanwhile the rest 85.33% are non-application tasks.

The arrangement of a textbook is important since it will influence how students construct mathematical idea (Sutherland, 2007), and here we see that contextual tasks in NSM and BSM are arranged differently. NSM arranges the tasks from non-application tasks followed by application tasks, and then the tasks are varied. This arrangement agrees with Seguin (1989) stated that textbooks are developed using a progression of content and learning activities; using simple concepts, complex ones until they are mastering the application to a variety of situations. Meanwhile, in BSM, the tasks are varied from the beginning of the unit. It might show that for the writer of the textbook, application tasks are not necessarily placed after the concepts of Pythagorean Theorem are fully mastered by the students, but it will also be seen as the textbook is not arranged sequentially as stated by Retnawati (2013). The latter might be the reason why teachers in Indonesia think that the difficulty level of the tasks in BSM are too high and it will affect the time allocation of teaching and learning process (Fajriatin, 2015; Muklis, 2015).

For the non-application tasks, NSM presents tasks such as asking students to identify the hypotenuse of the given right triangles, to show that given numbers forming Pythagorean Triplets, to find the unknown(s) an/or perimeter and area from the given right triangle, composite of right and/or scalene triangles and also other polygon that can be broken down into right triangles. Meanwhile, since BSM only presents 11 application tasks out of 75 tasks, the 64 non-application tasks are rich in variation. Other than similar tasks included in NSM, BSM also includes distinct tasks such as finding the relationship of the area of the three semicircles adjacent to sides of a right triangle, finding a complete Pythagorean Triplets given one or two members, and showing how to apply Pythagorean Theorem in three-dimensional figures.

Comparison of Degree of Openness of Tasks in NSM and BSM

In the degree of openness dimension, closed-ended tasks are the most common tasks found in NSM. This shows that NSM expects students to learn a definition or fact and to perform a skill. Meanwhile, open-middled tasks are the most common tasks found in BSM, which shows that BSM emphasizes more on revealing students' thinking throughout the solving process and also giving students opportunity to use their own strategies in solving tasks that are the most comfortable to them (National Council of Teachers of Mathematics, 2000). BSM also presents more diverse tasks that are not present in NSM, such as determining whether a triangle with given coordinates in Cartesian coordinate is a right triangle and making a conclusion on how are the ratios of 450–450–900 and 300–600–900 triangles.

Unfortunately, both NSM and BSM rarely present open-ended tasks. There are only four such tasks found in BSM and even no such task found in NSM. This lack in tasks will affect students in term of their motivation, creativity, and opportunity to be creative on using different strategies to construct response and solving problems (National Council of Teachers of Mathematics, 2000).

CONCLUSIONS

Representation Form. (1) No task of Pythagorean Theorem unit of both NSM and BSM that presented in purely mathematics form. (2) In both NSM and BSM, the combined representation form tasks can be divided into two types: application tasks in form

of word problems and also non-application tasks where visual representations given to students besides the verbal representation to help them visualizing the condition depicted by the tasks. (3) The tasks of the Pythagorean Theorem unit in NSM are majorly presented in verbal representation form. Meanwhile, the tasks in BSM are majorly presented in a combination form. (4) Since the scope of Pythagorean Theorem unit in BSM is broader than those of NSM, the tasks presented in BSM are also varied more.

Contextual Feature. (1) The tasks in NSM are exactly divided in half (50:50) into the application and non-application task, meanwhile tasks in BSM only presents 14.67% application tasks, and the rest 85.33% are non-application tasks. (2) NSM arranges the tasks from non-application tasks followed by application tasks, and then the tasks are varied. Meanwhile, in BSM, the tasks are varied from the beginning of the unit. (3) BSM presents a more diverse non-application task compared to those of NSM.

Degree of Openness. (1) The most common tasks found in NSM are closed-ended tasks; meanwhile, the most common tasks found in BSM are open-middled tasks. (2) Open-ended tasks are rarely found in both textbooks. Four tasks found in BSM and no tasks found in NSM.

The factors that may be related to the achievement difference of Singapore and Indonesia in international assessment such as PISA are: (1) the scope of the unit in Singapore mathematics textbook is not too wide hence students of the country can focus more on the important concepts of the unit; (2) students in Singapore are given more opportunity to solve application tasks; (3) Singapore textbook arranges the tasks from non-application to application tasks, from easier concepts into the more complex ones, basic level tasks to advanced level tasks; (4) Singapore uses a spiral approach, hence the textbook trying to relate the unit being studied to the previously learned units.

From the study, there are few suggestions proposed to the writer of the textbooks of both countries. To the Writers of NSM, suggestions that can be proposed to the writer of NSM are: (1) to continue using multiple representation forms in presenting the tasks, (2) to widen the scope of the Pythagorean Theorem unit, since the unit can also be related to other previously learned units such as Cartesian coordinates and radicals, (3) to continue on presenting application tasks in the textbook, (4) to add open-ended tasks in-to the textbook.

To the Writers of BSM, suggestions that can be proposed to the writer of BSM are: (1) to continue using multiple representation forms in presenting the tasks, (2) to consider whether the scope of the unit is too broad; removing any redundant scopes that might make students lose their focus of the important concepts of the unit, (3) to present more application tasks in the textbook, (4) to consider arranging the contextual feature of the tasks into application-non-application-alternate of both, (5) to present more open-ended task into the textbook.

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