MODESTUM
OPEN ACCESS
EURASIA Journal of Mathematics, Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
2018 14(4):1273-1286 DOI: 10.29333/ejmste/82625

A Comparative Analysis on Cognitive Domain for the Malaysian Primary Four Textbook Series

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Received 25 July 2017 ▪ Revised 23 November 2017 ▪ Accepted 19 December 2017

ABSTRACT

The purpose of this study is to investigate the levels of cognitive domains of Malaysian Mathematics primary four textbooks developed under the old and new curriculum based on Trends in International Mathematics and Science Study (TIMSS) 2015 Mathematics Framework. This study adopted content analysis where the mathematical tasks from the textbooks were classified in terms of type of tasks and cognitive domain. The results of the study showed that a large portion of mathematical tasks in the two textbooks are in the 'knowing' domain even though improvements have been made in the new version of mathematics primary four textbook which has more mathematical tasks in 'applying' and 'reasoning' domain compared to the old textbook. The findings of the study suggest the structure of Malaysian textbook to be updated to the current world changes by increasing the tasks in applying and reasoning domain. However, the effort to reduce the gap between the intended curriculum and the supporting textbooks need to be carefully planned such that students of different abilities can benefit. Meanwhile practitioners have to be smart in selecting and providing extra supplementary resources to serve the need of their students.

Keywords: textbook evaluation, cognitive domains, mathematical tasks, content analysis

INTRODUCTION

Schools in Malaysia aim to develop potential individual through quality education by preparing the new generation with the ability to think and to be a committed citizen (Malaysia, 2011). Thus, the Ministry of Education (MOE) in Malaysia continuously check the curriculum to prepare students with knowledge, skills and value to face future challenges as well as fulfilling the needs of the nation. In 2011, there is a major curriculum reform in Malaysia, in which the Integrated Primary School Curriculum or more commonly known in the Malay Language as *Kurikulum Bersepadu Sekolah Rendah* (KBSR) has been replaced with Primary School Standard Curriculum or more commonly known in the Malay Language as *Kurikulum Standard Sekolah Rendah* (KSSR). As for this reform, the curricular materials including the mathematics textbook has been changed to facilitate the implementation of the curricular intentions of KSSR.

Chronologically, the Education Act of 1961 has been the basis of education in Malaysia with the focus to implement nation unity and to prevent illiterateness among the people. It is the first curriculum changes after independence which in an essence, a gradual change from British education to Malaysian outlook and oriented curriculum (Haji Ahmad, 1998). At the end of 1970s, the societal and economic changes have been emphasized on science and technology. The system revolution has been reviewed to check whether it met the progressive needs of Malaysia and thus in 1979, a Cabinet Committee Report has been released. It emphasizes a holistic approach in term of intellectual, spiritual, physical and emotional at all level of schools. Therefore, in 1982, Primary School New Curriculum also known in Malay language as *Kurikulum Baru Sekolah Rendah* was introduced and replacing the old curriculum.

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Contribution of this paper to the literature

- By reporting the cognitive domain in the textbook, hopefully it will create awareness to the research community and the policymakers on whether the implemented curriculum is aligned with the intended curriculum.
- The study will bring into light to the world on how the current global emphasize on critical thinking affect the education reform in Malaysia as one of the countries in Southeast Asia especially in the field of textbooks establishment.

Next, when the National Educational Philosophy was introduced in 1988 (Malaysia, 1993), once again the curriculum was improved and *Kurikulum Baru Sekolah Rendah* or Primary School New Curriculum has been changed to *Kurikulum Bersepadu Sekolah Rendah* (KBSR) or Integrated Primary School Curriculum in 1993. When KBSR is mentioned in this paper, then it refers to *Kurikulum Bersepadu Sekolah Rendah* (KBSR) or Integrated Primary School Curriculum. KBSR orientation is based on the National Educational Philosophy which focuses on developing individuals in an integrated manner to be balanced holistically (intellectual, spiritual, physical & emotional) and harmonious based on firm belief in God.

According to Haji Ahmad (1998), KBSR aimed to reduce the heavy content oriented curriculum and concentrating more on the three Rs, Reading, wRiting and aRithmatic. KBSR focuses more on the student participation and the teaching activities were designed to encourage the communication through verbal skills. Learning takes place through variety of ways such as collaborative learning or individual learning. In primary school mathematics, the curriculum emphasizes on basic concepts such as additions, subtractions, divisions, and multiplications. The use of local materials and orientations that reflect Malaysian curriculum, were used in teaching and learning process.

Since the time has changed, once again, new curriculum was introduced in 2011 until now. Primary School Standard Curriculum or *Kurikulum Standard Sekolah Rendah* (KSSR) is focusing on to prepare the students to the challenges in the 21st century and follows the Standard Learning Document. The KSSR still maintains the principle of KBSR to develop student holistically. However, while KBSR focused on 3Rs, KSSR has four Rs and those are Reading, wRiting, aRithmatic and Reasoning. KBSR has previously emphasize on the element of critical and creative thinking skills and for the new KSSR, the elements has been extended to creative and innovative, entrepreneurship and information technology, and communication explicitly. The teaching and learning in mathematics emphasizes on the mastery of knowledge and understanding to enable students to apply learnt concepts, principles, and process of mathematics. The principles of learning in classes are focusing on problem-solving, communication, reasoning, relating, representing, and the use of technology in mathematics.

Even though it has been reported that KBSR is to substitute the *Kurikulum Baru Sekolah Rendah* to reduce the content knowledge of the old curricular (Haji Ahmad, 1998), however, the KBSR mathematics textbooks still mainly focused on content knowledge. As time goes by, the older textbook is insufficient to produce future generations that are competent to meet with the demand of fast changing society nowadays. Education system that focus on simple transmission of knowledge and memorization is no longer sufficient, education today must be able to produce students that can acquire 21st century skills so that they are able to adapt the ever-changing society and to be productive in life (Darling-Hammond, Barron, Pearson, Schoenfeld, Stage et al., 2008). Compared to KBSR, KSSR adopted student-centered pedagogy more attentively with the help from technology. This is to counter back the teaching and learning in Malaysia classroom which is mostly teacher-centered (Zakaria & Iksan, 2007). The KSSR mathematics textbooks do not only emphasize on the importance of knowledge, but also on developing students with multiple skills such as higher order thinking skills (HOTS), effective communication skills and the use of technologies (Ministry of Education, 2013). The KSSR textbook is expected to provide opportunities for students to engage in meaningful activities that help to develop higher order thinking skills.

In the past two decades, international student assessments, such as Trends in International Mathematics and Science Study (TIMSS) has emerged as a means to directly compare the quality of educational systems across different countries. TIMSS assesses students in Grade 4 (equivalent to Malaysian Primary Year 4) and Grade 8 (equivalent to Malaysian Secondary Form 2) on three cognitive domains, namely the thinking processes of knowing, applying, and reasoning. Malaysian ranking and average score in the mathematics subject for TIMSS has been plummeting from 1999 to 2011. In 2011, Malaysia students' average score had dropped to below the international average (Mullis, Martin, Foy, & Arora, 2012). It is then revealed that Malaysian students only possess basic mathematical skills and therefore they are unable to answer 'applying' and 'reasoning' questions (Ministry of Education, 2013b). This is becoming an alarming fact for these students will need to have competencies in Mathematics for them to survive in the outside world (Firouzian et.al, 2014). In 2015, Malaysian students' average score showed an increase to 465 points, but it was still below the international average (Mullis, Martin, Foy, & Hooper, 2016).

Furthermore, to accommodate to the current world reform, by 2016, higher order thinking questions will comprise at least 40% of questions in the Year 6 national examination, *Ujian Pencapaian Sekolah Rendah* (UPSR) to get students to put less focus on remembering facts and regurgitate during the examinations, instead they need to think critically and to apply their knowledge in different settings (Ministry of Education Malaysia, 2013b). UPSR is a standardized national assessment to evaluate the Year 6 or commonly 12 years old students' performance at the end of their primary level education. This means that UPSR will have more questions that require higher cognitive domain. Therefore, the KSSR textbook need to present mathematical tasks that better prepare students for UPSR. According to 2011 TIMSS survey, 83% of teachers in Malaysia used mathematics textbooks as basic of instruction for teaching mathematics (Mullis et al., 2012). Mathematics textbook is the dominant resource in many mathematics classrooms as majority of teachers follow the textbook for teaching mathematics. As mathematics textbook is an important resource in giving instruction in the classroom, the opportunities for students to develop essential thinking skills is dependent on it. Thus, there is a need to check the learning materials used to see whether the materials comprise enough aspect of higher order thinking skills in it and the KSSR textbook need to present mathematical tasks that better prepare students for UPSR.

As textbooks have a strong influence upon the learning of mathematics in Malaysia classroom, the cognitive domains of mathematical tasks in the textbooks require detail analysis. Cognitive domain here means that the cognitive level that is required for the students to solve the task based on the TIMSS 2015 Mathematics Framework which consists of three cognitive domain for primary school, knowing, applying, and reasoning (Grønmo, Lindquist, Arora, & Mullis, 2015). This study would give a clear picture on the differences between the cognitive domains of the textbook tasks between the two curricula.

ROLE OF TEXTBOOKS IN TEACHING AND LEARNING OF MATHEMATICS

The role of textbooks in teaching and learning has been studied extensively by some researchers. The meta-analysis conducted by Fan, Zhu, and Miao (2013) revealed that researchers have generally agreed that textbooks acted as the major conveyor of the curriculum and has a great influence in the current education scenes. The textbooks are designed to translate the abstract of the curriculum policy into operations that can be executed by teachers and students, and served as an intermediator between the developers of the curriculum policy and the teachers (Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). Mathematics textbooks can provide teachers the mathematical content to be taught, the pedagogy, teaching strategies and activities that can be done during the teaching and learning process (Erbas, Alacaci, & Bulut, 2012; Sağlam & Alacaci, 2012; Shield & Dole, 2009; Nie, Freedman, Hwang, Wang, Moyer, & Cai, 2013) and it can also show the ways students should learn the topics in the curriculum, the activities and exercises that can be done in the classroom (Johansson, 2005; Törnroos, 2005; Stylianides, 2009). Similarly, Porter (2002) found that textbook influence teachers' decisions on what content to teach, how to teach and when to teach their students. Moreover, the mathematical tasks such as examples, activities, exercise provided by the textbook form the main focus for the mathematics classroom instructions (Silver, Ghousseini, Charalambous & Mills, 2009; Pepin & Haggarty, 2001; Thomson & Fleming, 2004). Thus, by the information and instruction provided in the textbook, it can automatically perform the intended curriculum in the class.

According to Brehmer, Ryve, and Van Steenbrugge (2016), the major resource for students' in classrooms is textbook because it functioned as an intermediate to develop their own understanding on the mathematical concepts (Weinberg & Wiesner, 2011). Richards (2001) expressed that textbook provides structure and presented the syllabus for a subject. Most of the time teachers are provided with the mathematics curriculum, however students do not have access to the curriculum and they could not comprehend the curriculum. Textbook which was systematically planned and developed according to the curriculum provide teachers and students information about the curriculum without the need to refer to the curriculum itself. Moreover, textbooks are designed in such a way to be visually attractive to stimulate students' interest in the subject and hence make it easier to achieve the learning outcomes as desired by the curriculum (Mohammadpour & Abdul Ghafar, 2014).

Next, textbook ensures the quality of content provided to the students. The development and construction of textbook are based on learning theories and design according to the need of the current education context. Therefore, textbook is an efficient tool for teachers so that they can spend more time in teaching instead of producing learning materials for students. A mathematics textbook helps students learning in two ways, one way is by reading the examples and explanation found in the textbook and the other way is by doing exercises and solves problems from the textbook to consolidate learning (Erbas et al., 2012).Since textbooks is the main source in Malaysia, so, Mathematics textbooks must contain mathematical tasks that help students to develop critical thinking skills.

Furthermore, textbook helps to standardize instruction across states, schools and classrooms. The use of the same textbook will ensure that students from different classrooms will be taught the similar content as they will be assessed by the centralized examination. Malaysian students need to take centralized examination when they finish

their primary school and secondary school education. So, learning similar content enable them to be assessed in the centralized examination fairly.

Rezat (2006) described textbooks as a set of dichotomies. Textbooks serve as a pedagogical tool and also a marketable product. Mathematics textbooks are developed to facilitate teaching and learning of mathematics in the classroom. However, publishing mathematics textbooks can also means business for the publishers. The publishers will need satisfaction from the customers, both teachers and students. Similarly, Richards (2001) expressed that textbook are commercial product when the authors and publishers can construct of the textbooks according to the guide by Ministry of Education effectively. The main concern of the authors of textbooks is to produce innovative, creative, tailored to the teaching needs of teachers and learning needs of students. In the consideration of the publishers, the textbooks need to be profitable and consequently it must be excellent in qualities to stand out from the other competitors. Although mathematics textbooks were designed to be an instrument for learning, it can also be regarded as a tool to develop mathematical skills from the well-structured mathematical problem provided in the text book (Lee, Koh, Cai, & Quek, 2012).

Although different researchers described various role of textbooks in teaching and learning of mathematics differently, but all of these literatures pointed out that textbooks play an important role in teaching and learning of mathematics.

PREVIOUS STUDY ON TEXTBOOK EVALUATION

Textbook evaluation has been conducted by many researchers using different conceptual or theoretical frameworks depending on the research objectives. Textbook evaluation often involves a series of textbooks from a country to identify possible sources of problems in the textbooks or a cross comparison of textbooks from different countries to identify their similarities and differences. Shield and Dole (2009) analyzed Australian mathematics textbook series for year eight, nine and ten, and found out that these textbooks lack of features that promote deep understanding. Although the examined textbooks consist of a variety of features that are helpful in teaching and learning of mathematics, make use of daily life situations, however, they focus on low level procedural exercise. They argued that due to the absence of such features, teachers must take more efforts in helping students to develop HOTS. Thus, educational materials especially textbooks need to be scrutinized more closely since textbooks are one of the primary resources in implementing mathematics curriculum.

Stylianides (2009) proposed a methodological approach to examine the opportunities provided by the selected United States mathematics textbooks to engage students in reasoning and proving activities. Although there is an increase in recognition for engaging students in reasoning and proving activities, the study found out that about 40% of the mathematical tasks provide such opportunities and more than 50% of the tasks did not provide any chances for involvement of students in such activities.

Charalambous, Delaney, Hsu, and Mesa (2010) examined primary mathematics textbooks from Cyprus, Ireland and Taiwan on addition and subtraction of fractions. They developed their own framework based on literature they have reviewed and selected six criteria to characterize textbooks. The study revealed that more than 85% of mathematical tasks in textbooks from Cyprus and Ireland demand low cognitive domain, and more than 70% of mathematical tasks in textbooks from Taiwan were demanding high cognitive domain.

Bayazit (2012) analyzed the quality of the mathematical tasks related to the topic of proportion in Turkish elementary textbooks in terms of level of cognitive demands. Level of cognitive demand means the kind of thinking processes to solve the tasks. Bayazit considers lower-level demands to include memorizations and procedures without connections and higher-level demands are related to the process of connections and doing mathematics while solving the task. The results showed that 25% of the tasks had low cognitive demands and 75% of the tasks had high cognitive demands. Moreover, the high cognitive demand tasks are shown in numerous presentations and often these tasks involved daily life situations. A similar study carried out by Ozgeldi and Esen (2010) examined mathematical tasks in the Turkish elementary school textbooks of grade 6, 7 and 8 and the findings revealed that most of the mathematical tasks required low level of cognitive demands. They conclude that these tasks in the textbooks do not align with the aim of the mathematics curriculum to provide more opportunities to students to develop higher order thinking skills.

Jones and Tarr (2007) examined the cognitive demands of the probability content for two series of grade 6, 7 and 8 textbooks for four recent eras in mathematics education of United States. As for the study, the researcher distinguish the cognitive demand into memorizing, performing procedures, communicating understanding of concepts; solving non-routine problems; and conjecturing, generalizing, and proving for which the researcher also considers lower-level demands to include memorizations and procedures without connections and higher-level demands are related to the process of connections and doing mathematics. They found out that for most series the probability tasks required low levels of cognitive demand. However, there was an exception from one series of textbooks where the 59% of the tasks required high level of cognitive demands. This series of textbooks adhered to

the need to include more tasks of high level of cognitive demands, to support the development of deeper understanding with respect to the mathematical concepts and relationships.

Analysis of mathematics textbooks in terms of cognitive demands has been conducted on textbooks from many different countries. Most of the finding indicated that vast majority of the tasks or features in textbooks required low cognitive demands and address the need to provide more opportunities for students to develop higher order thinking skills in students. Therefore, in this study, we are going to report the difference of the mathematics task in both KBSR and the improved KSSR. There are three cognitive domains (knowing, applying, and reasoning) and for current study, we consider the knowing domain as low cognitive demand and applying and reasoning to be in high cognitive demand.

The levels of cognitive domains of the mathematical tasks in this study were determined using the conceptual framework based on the cognitive dimension of TIMSS 2015 Mathematics Framework. TIMSS 2015 Mathematics Framework was built on TIMSS about 20-year history of assessment which involved multiple experts and is constantly being updated to ensure that it is relevant to the current education context (Mullis, Martin and Foy, 2005). The cognitive dimensions involved the thinking processes of knowing, applying, and reasoning. According to Mullis, Martin and Foy (2005) the knowing domain refers to the students to be aware of the facts, procedures, and concepts. As for applying domain, it is the state for which the concepts and understanding learnt could be practiced in the task or in routine problems while the reasoning domain according to (Sturman, Ruddock, Burge, Styles, Lin, & Vappula, 2008) represents the analyzing, generalizing, synthesizing, justifying and solving non-routine problems.

Thus, by referring to Grønmo et al. (2015) for the knowing domain, there are six aspects that were considered under this cognitive domain. Those are recall, recognize, classify / order, compute, retrieve and measure. For applying domain, the aspects include determine, represent / model and implement. Lastly, the aspects for reasoning domain cover for analyze, integrate / synthesize, evaluate, draw conclusions, generalize and justify. These aspects were adapted in the current study to identify the mathematics tasks which falls under respective domain and the author refer to the meaning of the aspects from Grønmo et al. (2015). In another words, the mathematics tasks were classified under the three domains of knowing, applying, and reasoning based on the aspects from each of the domain.

METHODOLOGY

Implementation of KSSR aimed to foster critical thinkers with higher order thinking skills. Textbooks are the primary resource for teachers to understand the intended curriculum. In order for the successful implementation of KSSR, the textbook must contain tasks that provide opportunities for students to develop higher order thinking skills. The main purpose of this research is to identify the levels of the cognitive demands in mathematical tasks in primary four KBSR and KSSR textbooks. This research has three objectives: (1) to identify the cognitive domains of the explanation and assessment tasks in primary four KBSR and KSSR mathematics textbooks, (2) to determine the differences in the cognitive domains of the explanation and assessment tasks between KBSR and KSSR mathematics textbooks and (3) to identify the cognitive domains of the mathematical tasks according to topics in primary four KBSR and KSSR mathematics textbooks.

Materials

The research design was qualitative as also adopted by Brehmer et al. (2016) who analyzed mathematical problem solving for upper secondary mathematics textbook. This study adopted content analysis method to compare the mathematical tasks from the KBSR and KSSR mathematics year 4 textbooks on cognitive domains of TIMSS. The research design was qualitative research. This study adopted content analysis method to compare the mathematical tasks available in the KBSR and KSSR mathematics year 4 textbooks according to cognitive domains of TIMSS Mathematics textbook of year 4 was chosen because during the beginning of the review, KSSR was newly implemented and only year 1 until year 4 use the new curricular. Therefore, the author consider the year four textbooks because according to Piaget's cognitive development of children, at the age of 7-10 years old (Piaget, 1972), children is in the stage of applying logic and reasoning to concrete events. Therefore, it is likely suitable to introduce the children to the higher order thinking skills at this range of age. Simultaneously, the author choose the mathematics textbook for the 10 years old student (primary 4, year 4 or grade 4) because it is the highest primary year textbook available in the KSSR when authors begin the review. These two textbooks were the official textbooks published under the approval of Ministry of Education (MOE) Malaysia. In Malaysia, all primary textbooks were developed under the supervision of Textbook Division to make sure that the textbooks were aligned with the curriculum intentions.

Table 1. Meaning of each aspect in Knowing, Applying and Reasoning domain (Grønmo et al., 2015)

Knowing Domain	
Aspect	**Meaning**
Recall	Recall definitions, terminology, number properties, units of measurement, geometric properties, and notation (e.g., $a \times b = ab$, $a + a + a = 3a$).
Recognize	Recognize numbers, expressions, quantities, and shapes. Recognize entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals, and percents; different orientations of simple geometric figures).
Classify / Order	Classify numbers, expressions, quantities, and shapes by common properties.
Compute	Carry out algorithmic procedures for +, –, ×, ÷, or a combination of these with whole numbers, fractions, decimals, and integers. Carry out straightforward algebraic procedures.
Retrieve	Retrieve information from graphs, tables, texts, or other sources.
Measure	Use measuring instruments; and choose appropriate units of measurement.
Applying Domain	
Aspect	**Meaning**
Determine	Determine efficient/appropriate operations, strategies, and tools for solving problems for which there are commonly used methods of solution.
Represent / Model	Display data in tables or graphs; create equations, inequalities, geometric figures, or diagrams that model problem situations; and generate equivalent representations for a given mathematical entity or relationship.
Implement	Implement strategies and operations to solve problems involving familiar mathematical concepts and procedures.
Reasoning Domain	
Aspect	**Meaning**
Analyze	Determine, describe, or use relationships among numbers, expressions, quantities, and shapes.
Integrate / Synthesize	Link different elements of knowledge, related representations, and procedures to solve problems.
Evaluate	Evaluate alternative problem-solving strategies and solutions.
Draw conclusions	Make valid inferences on the basis of information and evidence.
Generalize	Make statements that represent relationships in more general and more widely applicable terms.
Justify	Provide mathematical arguments to support a strategy or solution.

Analytic Criteria

The mathematical tasks within the two mathematics textbooks were analyzed using two types of analytic criteria: type of task and cognitive domain. Firstly, the mathematical task is classified into two categories, which are explanation tasks and assessment tasks. All tasks in the textbooks that include examples, guided activities, enrichment activities, challenging questions, formative exercise, summative exercise and revision exercise were analyzed. Explanation tasks require the students to explain the underlying mathematical concepts, create relationship with mathematical ideas and present the mathematical procedures. The tasks that was regarded as explanation tasks are examples and guided activities. On the other hand, assessment tasks include the enrichment activities, challenging questions, formative exercise, summative exercise and revision exercise, those tasks in the textbook utilize the skills of students to assess the mathematical concepts, ideas and procedures presented in the textbooks. The mathematical tasks that built on one another were regarded as a single task.

After the type of task had been classified, each mathematical task in these textbooks is then classified based on three cognitive domains: (1) knowing, (2) applying and (3) reasoning based on TIMSS 2015 Mathematics Framework (Grønmo et al., 2015). For the mathematical task coded under the cognitive domain of knowing, it is further analyzed according to six aspects: (1) recall, (2) recognize, (3) classify / order, (4) compute, (5) retrieve and (6) measure. For mathematical tasks coded under the cognitive domain of applying, it is analyzed according to three aspects: (1) determine, (2) represent / model and (3) implement. As for mathematical tasks coded under the cognitive domain of reasoning, it is analyzed according to six aspects: (1) analyze, (2) integrate / synthesize, (3) evaluate, (4) draw conclusions, (5) generalize and (6) justify. The framework was chosen as it simplifies the cognitive domain that was tested in TIMSS. Since Malaysia are now focusing more on the international assessment and the assessment itself was used worldwide, it is chosen as the most suitable framework to be used in the current study to give better insight of the study to the world. The meaning of each aspect in each domain which is used in the current study was taken from TIMSS 2015 Mathematics Framework (Grønmo et al., 2015) and can be referred to **Table 1**.

Table 2. The mapping of assessment task in knowing domain

Mathematical task in the textbook: 63 085 + 5 596 =		
Type of task	Assessment task	Coded as assessment task because it is an exercise to assess addition skills
Cognitive domain	Knowing	Coded as knowing because addition is a basic mathematical skill
Aspect of the cognitive domain	Compute	Coded as compute because it involved algorithmic procedure of addition

Table 3. The mapping of assessment task in applying domain

Mathematical task in the textbook: The total cost of two cardboards is RM1105.90. If one cardboard costs RM548.00, find the cost of the other cardboard.		
Type of task	Assessment task	Coded as assessment task because it is an exercise to assess problem solving skills
Cognitive domain	Applying	Coded as applying because it is a routine problem
Aspect of the cognitive domain	Implement	Coded as implement because it required implementation of subtraction operation to solve the problem

Table 4. The mapping of assessment task in reasoning domain

Mathematical task in the textbook: Write a story from the following number sentence. You may use these words: flour, use, amount, bake, left. $\frac{5}{8}$ kg - $\frac{1}{4}$ kg = $\frac{3}{8}$ kg		
Type of task	Assessment task	Coded as assessment task because it is an exercise to assess addition skills
Cognitive domain	Knowing	Coded as knowing because addition is a basic mathematical skill
Aspect of the cognitive domain	Compute	Coded as compute because it involved algorithmic procedure of addition

Table 5. Distribution of Cognitive Domain across Mathematical Tasks

	Explanation tasks		**Assessment tasks**	
	KBSR	**KSSR**	**KBSR**	**KSSR**
Knowing (Percentage)	189 (66.8)	154 (53.5)	1057 (74.6)	726 (61.1)
Applying (Percentage)	94 (33.2)	134 (46.5)	340 (24.0)	386 (32.5)
Reasoning (Percentage)	0	0	19 (1.3)	76 (6.4)

Analytic Methods

Each mathematical task in the textbooks is coded according to the type of tasks, cognitive domain and the aspect of the cognitive domain. **Table 2** displays an example for the mapping of assessment task in knowing domain while **Table 3** and **Table 4** shows the mapping of assessment task in applying and reasoning domain respectively.

The mathematical tasks were coded by one researcher. In order to provide validity and reliability of the data, two reviewers independently coded the mathematical tasks and were compared to the researcher's codes. The reviewers were trained to code the mathematical tasks based on the coding scheme of this study and pilot coding was conducted prior to coding of the mathematical tasks. Each reviewer coded approximately 30% of the total mathematical tasks which was considered as a reliable subsample (Potter & Levine-Donnerstein, 1999; Wimmer & Dominick, 2012). The inter-coder agreement reached more than 90% for simple percentage agreement and kappa statistics. Inter-coder agreement for simple percentage exceeds 90% indicate high consistency among the coders (Lombard, Snyder-Duch, & Bracken, 2002). Kappa statistics in the range of 0.81 to 0.99 indicate almost perfect agreement (Viera & Garrett, 2005). Thus, there is a high agreement among the researcher and the reviewers.

RESULTS

The mathematical tasks in KBSR and KSSR textbooks were analyzed. The KBSR textbook contained 1699 mathematical tasks whereas the KSSR textbook contained 1476 mathematical tasks. **Table 5** shows the descriptive statistics of cognitive domain across types of mathematical tasks in the KBSR and KSSR textbooks respectively. **Figure 1** displays the distribution of cognitive domain across explanation tasks and assessment tasks in the two textbooks in terms of percentages. Clearly, majority of the explanation tasks and assessment tasks fall under the knowing domain. Although most of the explanation tasks were in knowing domain for KSSR textbook, the proportion of tasks in knowing domain was reduced and the tasks in applying domain has increased as compared to the KBSR textbook. However, both textbooks did not provide any explanation tasks in reasoning domain. Similarly, most of the assessment tasks were in knowing domain for KSSR textbook, the proportion of tasks in knowing domain was reduced and the tasks in applying and reasoning domain has increase as compared to the KBSR textbook.

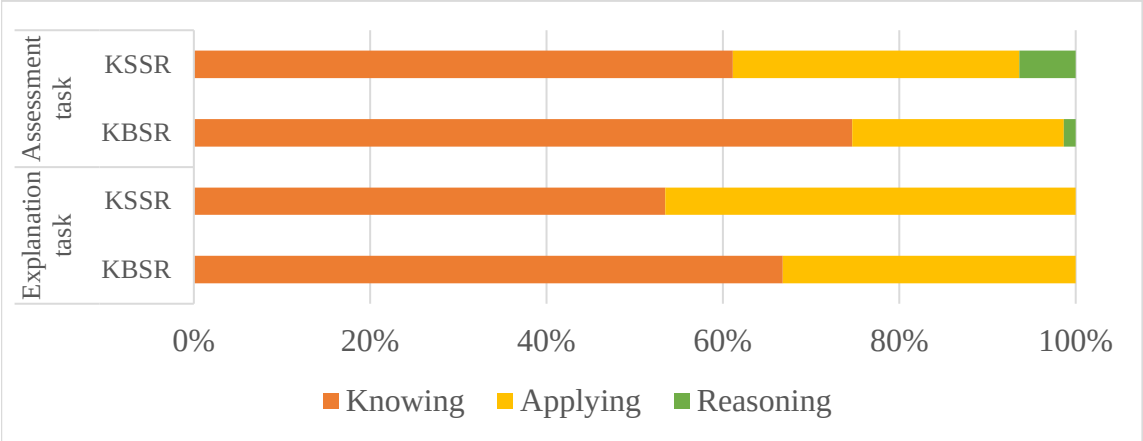

Figure 1. Percentages for Cognitive Domains across Explanation Tasks and Assessment Tasks

Table 6. Number of Mathematical Tasks in Each Aspect of the Cognitive Domains

	Explanation tasks		Assessment tasks	
	KBSR	**KSSR**	**KBSR**	**KSSR**
Knowing				
Recall	5	0	2	0
Recognize	35	27	155	140
Classify / Order	1	5	16	28
Compute	114	105	822	490
Retrieve	11	12	21	51
Measure	23	5	41	17
Applying				
Determine	0	0	0	5
Represent / Model	4	4	12	20
Implement	90	130	328	361
Reasoning				
Analyze	0	0	13	45
Integrate / Synthesize	0	0	6	9
Evaluate	0	0	0	15
Draw conclusions	0	0	0	2
Generalize	0	0	0	3
Justify	0	0	0	2
Total	283	288	1416	1188

Table 6 shows the number of mathematical tasks in each aspect of the cognitive domains. A vast majority of the explanation tasks in knowing domain was categorized as compute, the tasks were to show algorithmic procedures which is an essential component that students need to know. Students need to master these skills as these are essential in problem solving. The nature of the explanation tasks is to provide explanation to the underlying mathematical concepts where operations, strategies and tools for problem solving will not only determine and model in a mathematical relationship but also will be implemented the strategies. Hence, most explanation tasks in applying domain are categorized as implement because the process of determine the appropriate operations, strategies and modeling of the problem situations are included in the implementation process. Likewise, for assessment tasks a large portion of the tasks is in knowing domain categorized as compute and majority tasks in applying domain was categorized as implement.

Figure 2 summarizes the distribution of cognitive domain across new topics in KSSR textbook in terms of percentages. The analysis shows that for Coordinates and Percentages, the majority of the tasks fall under the knowing domain except for proportions which have no tasks in knowing domain at all.

Figure 3 summarizes the distribution of cognitive domain across similar topics in the two textbooks in terms of percentages. Majority of the common topics are consistent with the general trend that the proportion of tasks in knowing domain for KSSR textbook was relatively decreased, and the tasks in applying and reasoning domain has increased as compared to KBSR textbook.

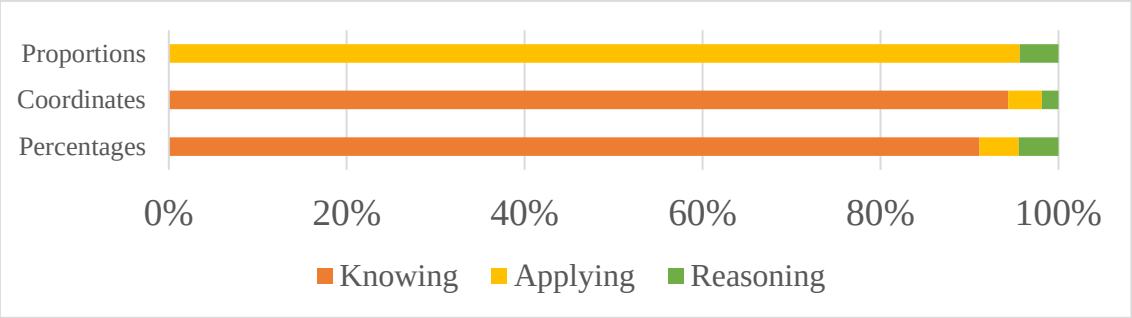

Figure 2. Percentages for cognitive domains across new topics in KSSR textbook

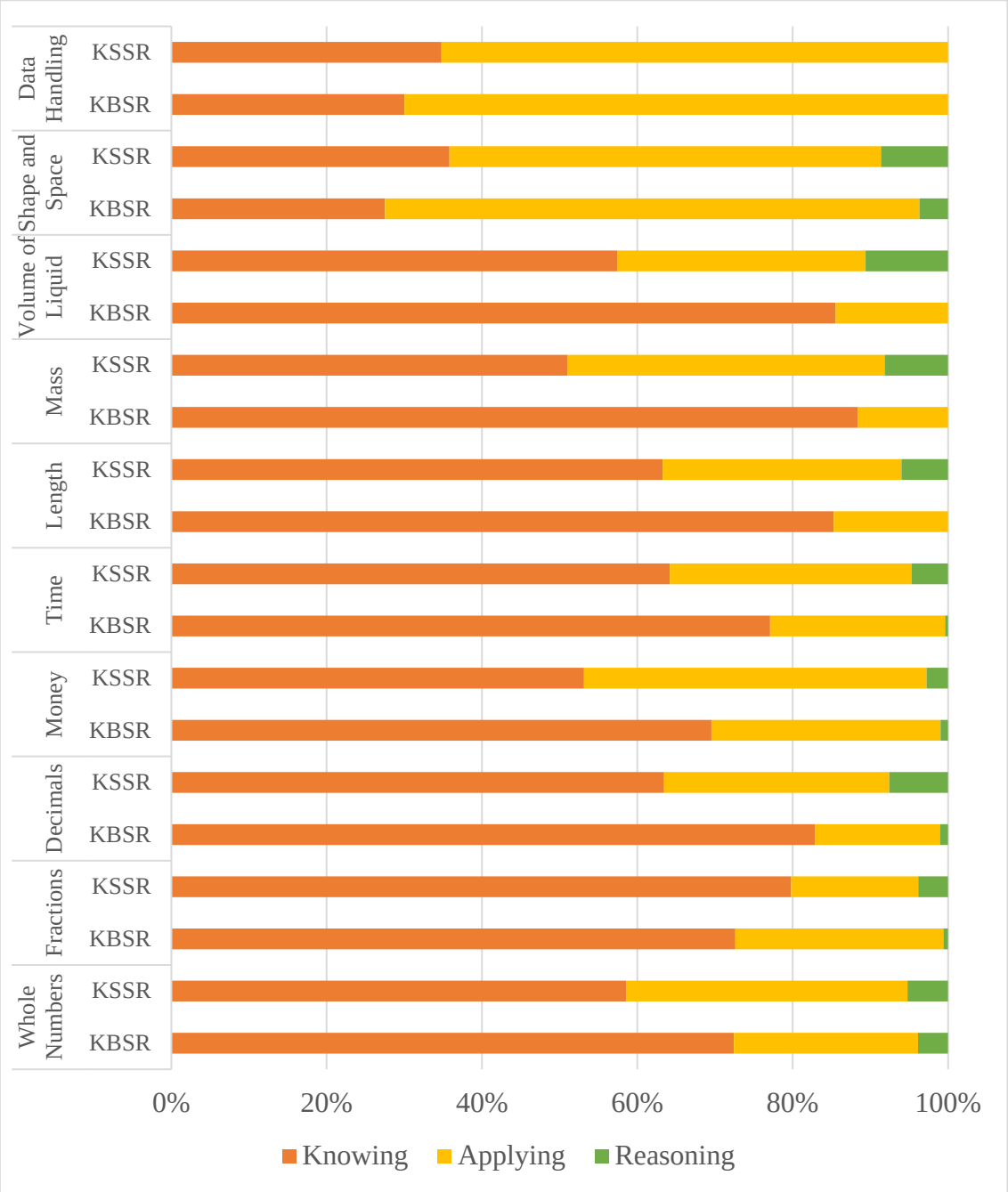

Figure 3. Percentages for cognitive domains across similar topics

DISCUSSIONS

The purpose of this study is to identify the cognitive domains and to determine the differences of the cognitive domain of mathematical tasks in primary four KBSR and KSSR mathematics textbooks. Most of the mathematical tasks fall under knowing domain which these tasks demand low level of cognitive such as memorizing facts and basic calculation (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009).

The explanation tasks in the two textbooks involved the cognitive domain of knowing and applying. In particular, both textbooks do not provide any explanation tasks in the reasoning domain. Reasoning domain as described by Grønmo et al. (2015) requires students to do logical thinking and systematic thinking to solve non-routine problem. However, the explanation task is the type of task that require student only to explain the facts and concepts, and sometimes might need to apply them in simple calculation. They would not need to do any reasoning such as the aspects under the reasoning domain and as a result, there is no reasoning domain available in explanation task but it is emphasized in assessment task.

For explanation tasks, the proportion of tasks in knowing domain for KSSR textbook was relatively decreased compared to KBSR, while the tasks in applying domain has increased. This implies that through the KSSR textbook students were exposed to more application of mathematics in a variety of contexts, rather than repeatedly showing algorithmic procedures without creating meaning. Textbook is an important instructional resource to shape the mathematics education specifically at primary level, textbook should consist of mathematical tasks that can foster student's creative thinking and reasoning skills (Pang, 2008). The richness and quality of the tasks in textbooks impacts in significant ways the opportunities for learning mathematics (Chávez, 2003). Thus, students need to be expose to the tasks that require higher level of cognitive demands to foster their creative thinking and reasoning skills. Besides that, plainly showing how to do just calculation has been discouraged in the KSSR textbook since the textbook contained more daily life situations. This is to expose students to application of mathematical concepts in their everyday life.

The assessment tasks in the two textbooks involved all the three cognitive domains of knowing, applying and reasoning. The majority of the assessment tasks fall under knowing domain. Considering the assessment tasks in reasoning domain, these tasks attempt to foster students' mathematical reasoning skills. The proportion of the tasks in knowing domain for KSSR textbook was relatively decreased and the tasks in applying and reasoning domain has increased as compared to KBSR textbook. This implies that through the KSSR textbook, the mathematical tasks intend to nurture students' problem solving and reasoning skills. Moreover, it is also shows that KBSR textbook emphasize on drilling the algorithmic procedures and improvement has been made in KSSR textbook to involve more real-life situations and provide more opportunities for students to reason. The increase of tasks in the applying and reasoning domain indicate that the KSSR textbook put more emphasis and efforts in developing students' problem-solving skills than the KBSR textbook.

This study examined the cognitive domain of the mathematical tasks in common topics of the two textbooks. Majority of the topics are distributed with the proportion of tasks in knowing domain for newer curricular textbook (KSSR) was relatively decreased while the tasks in applying and reasoning domain has increased as compared to older textbook (KBSR). There are three topics, namely Fractions, Shape and Space, and Data Handling did not follow the general trend, the possible reason could be the mathematics curriculum for KSSR is different from KBSR and they demand different skills in these topics.

Data handling have no reasoning task for both. Applying domain decrease between KBSR and KSSR. Data handling at the level of primary school in Malaysia requires students to retrieve the information from a variety of sources such as texts, bar graphs, and pictographs (Ismail, Voon & Wei, 2015). Currently they still have not learnt the statistics and probability such as mean, median and mode in primary four and according to the curriculum (Malaysia, 2011), the students only need to know and understand the data. Thus, there is no reasoning domain available in the Data Handling topic.

In Fraction and Shape & Space topic, it differs from the other topic as the tasks in reasoning domain increases, but it decreases in applying domain. It shows here that the textbook developer emphasizes these topics to be more in the reasoning domain than applying domain. Looking back at the syllabus (Malaysia, 2011), the topic of Shape and Space require students to understand the angle, perpendicular and parallel lines, the perimeter and area, and the volume of cube and cuboid while the topic of fraction require students to understand the basic concepts of fraction, to apply the subtraction and addition of fractions and to solve problems by using fractions. The applying domain in fraction such as to apply the subtraction and addition of fractions were reduced to give more emphasize on the reasoning domain to solve daily problems with various strategies (Malaysia, 2011). The same goes to the topic of Shape and Space which consists of formulas for the perimeter, area and volume of cuboid and cube. The developer of the textbooks focused on the reasoning domain so that the students will not only focus on remembering the formula of the volume but rather to understand it completely.

Other than that, we can see from **Figure 3** that there is no knowing domain in the topic of proportion. According to the syllabus (Malaysia, 2011), in the topic of proportion there is only one learning standard for the topic and that is students should be able to determine a value by using the unitary method in daily situation. Thus, the tasks were focused on the applying and reasoning domain only. Students only need to understand and apply the concepts that they learnt. There is no need for memorizing the facts.

For Whole Numbers, the number of mathematical tasks in KSSR textbook is significantly higher than KBSR textbook. This implies that the KSSR focus more on the topic of Whole Numbers. For Fractions, Decimals, Time, Length, Mass and Volume of Liquid, the number of mathematical tasks in KSSR were reduced as compared to KBSR textbook. This indicate that the KSSR put less focus on these topics. For Money, Shape and Spaces, and Data Handling, the number of tasks are similar in the two textbooks, attention paid in these topics remain the same. There are three new topics introduced in KSSR textbook, namely Percentages, Coordinates and Proportions. Since the content in Percentages and Coordinates are new to primary four students, all the explanation tasks are in knowing domain and the assessment tasks are available in all three cognitive domains. The assessment tasks do not only consolidate students learning but it also includes tasks that require mathematical thinking. For most of the topics, majority of the explanation tasks and assessment tasks are in knowing domain. The inadequacy of mathematical tasks demanding higher order thinking in certain topics of mathematics textbooks was also reported in two studies, one by Vincent and Stacey (2008) and the other by Shield and Dole (2009). Often, mathematics textbooks are compilations of mathematical tasks that was aligned to the current world development and as we see from the result, the Malaysian Ministry of Education has reformed the textbooks to be on par with other countries in term of its education by increasing the task that require better cognitive to be solved.

According to the analysis, a large portion of the explanation tasks and assessments tasks are still in the knowing domain, despite the overall improvement from KBSR to KSSR textbook. There is a gap between the intention of the mathematics curriculum of KSSR and the textbook. There are some other studies that discuss the considerable gaps that exist between national syllabuses or curriculum standards and the mathematics textbooks in China, Singapore and United States (Fan & Zhu, 2007). The gap between KSSR curriculum and textbook can be alleviated by providing additional materials that contain mathematical tasks involving HOTS to help teachers to better implement the curriculum. Moreover, the low level of cognitive demand as provided in the textbook should not remain the same in the classroom instructions (Stein, Grover & Henningsen, 1996), teachers need to have the flexibility to modify and create tasks according to the need of their students and improve the implementation of the curriculum. Teachers do not only select and set up worthwhile mathematical tasks appropriately, but teachers must also consistently support students' cognitive activity (Henningsen & Stein, 1997).

The revised KSSR mathematics curriculum commence to be implemented on 2017 for primary year 1 students and will be fully implemented on 2022 for standard 1 until 6, together with the implementation of the revised KSSR mathematics curriculum, new mathematics textbooks will be developed. All parties involved in textbooks production need to keep in mind the importance of the tasks' cognitive domain required to be solved when implementing revised KSSR mathematics curriculum. The new textbooks should have more mathematical tasks that have higher level of cognitive domain by increasing the task in applying and reasoning domain so that it exceeds the number of task in knowing domain. By emphasizing more on applying and reasoning domain, it can facilitate higher order thinking skills for students when teachers use it as main source of learning in classes.

CONCLUSIONS AND IMPLICATIONS

This study investigated the cognitive demands of the primary four KBSR and KSSR mathematics textbook. The findings of this study showed that the tasks in the knowing domain was predominant in both textbooks. This may explain partly why Malaysian students experience difficulties in solving problems which require applying and reasoning skills in international student assessments. Although the number of tasks in applying and reasoning domain of KSSR textbook have increased, the majority of the tasks are still in the knowing domain which require low level of cognitive demand. Educators need to be aware of the gap between the intended mathematics curriculum and the mathematics textbooks in order to help students to bridge the gap (Son, 2012). Levels of cognitive demands of mathematical tasks in KSSR textbook is still fallen short in terms of developing HOTS due to lack of opportunities exhibit in the textbook. In a study by Ozgeldi and Esen (2010), majority of the mathematical tasks in the mathematics textbooks require low level of cognitive demand but the mathematics curriculum emphasize on fostering HOTS in students. This is a paradox between the curriculum and the textbook developed and it is not unique in Malaysia only. The awareness of the existence of the gap is useful among teachers. As practitioners facing students of diversified abilities, they have to carefully select tasks that meet the need of their students. As a matter of fact, they could not rely merely on textbooks alone but might need to use or develop other appropriate resources to achieve effective teaching.

This study has implications for teachers, curriculum developers, textbook authors, publishers and researchers. They should be aware of the gap between the intention of the mathematics Year 4 curriculum of KSSR and the

textbook. However, this textbook analysis cannot infer on how teachers utilize the mathematical tasks in the textbook while conducting lessons. Instead, it offers meaningful interpretation on the mathematical tasks to see whether the tasks consistent to what is required by the curriculum. The distribution of the level of the cognitive demand does not reflect the quality of the textbooks, rather it focused on the learning opportunities that provide by the textbook to foster mathematical thinking skills. Moreover, this study may not provide straightforward contribution to the international community, mainly because only Malaysian textbooks were compared. However, the comparison of two textbooks from different curricula allowed us to identify the probable cause of certain issues and suggest what can be done to solve such issues.

Clearly, textbook analysis provides valuable information regarding the curriculum materials and it is worth studying. This study only captures the levels of cognitive domain of the primary four textbooks and cannot reflect the levels of cognitive domain for other primary level. Further research can be done on other primary level to gain further understanding of levels of cognitive domain in the primary mathematics textbooks. Other than that, future study can compare textbooks from different countries to provide insights on the similarities and differences of one country textbooks with another (Silver, 2009).

The finding of the study informs the community on the important aspect of the curriculum reform in Malaysia which aims to align with the current world development by implementing the 21st century learning in the curriculum. By reporting the cognitive domain in the textbook, hopefully it will create awareness to the research community and the policymakers on whether the implemented curriculum, in this case it is the learning source such as textbooks is aligned with the intended curriculum. The study might be interesting to publishers, authors of the textbooks, and the teachers and students as the users as it pinpoints the domain of cognitive that is available in the textbooks. It suggests to teachers and textbook writers regarding the task quality to be selected and implemented in class. Hopefully with this report, it will bring into light to the world on how the current global emphasize on critical thinking affect the education reform in Malaysia as one of the countries in Southeast Asia especially in the field of textbooks establishment.

ACKNOWLEDGEMENTS

We are thankful to Universiti Teknologi Malaysia and The Malaysian Ministry of Education for providing financial support through the FRGS grant R.J130000.7831.4F942 to make this research possible.

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