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The Distribution of Addition and Subtraction Word Problems in Bruneian Elementary Mathematics Texts

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Abstract

Mathematics textbooks and workbooks are an integral part of teaching and learning mathematics in Brunei Darussalam. Textbooks are written to closely reflect the contents of the Brunei Primary Mathematics Curriculum. They are widely used by teachers and students both in schools and at home. The study evaluated the distribution of addition and subtraction word problems according to categories proposed by Van De Walle (1998) in Primary 1-3 texts developed by Curriculum Development Department, Ministry of Education, Brunei. A document analysis methodological approach utilizing the descriptive design was used in analysing the distribution of the type of word problem categories involving addition and subtraction operations in Primary 1, Primary 2 and Primary 3 textbooks, together with the accompanying activity books for each grade. The analysis of texts revealed that out of 11 categories of addition and subtraction word problems proposed by Van De Walle, several of the categories were either not represented at all or inadequately represented in these texts. Word problems dealing with simple addition and subtraction were over represented whereas problems dealing with higher order thinking were less frequently represented, thus inhibiting pupils' ability to learn these operations meaningfully. The study offers suggestions on (i) creative methods for the introduction of different categories of addition and subtraction word problems over the period, (ii) implications of the study for teachers and curriculum developers and (iii) future research directions.

Introduction and Background

Mathematics textbooks and workbooks (texts) are an important and integral part of classroom life in elementary and secondary schools in most countries of the world. Textbooks provide a framework for thinking about what will be taught, how it will be taught and to whom it will be taught. The intended and implemented curriculum in the mathematics classrooms is often defined by grade-specific texts, and teachers, as well as students, spend a great deal of their preparation, class, and homework time working with textbook materials (Apple, 1992; Ben-Peretz, 1990; Goodlad, 1984; Schmidt et al., 1997). In mathematics classrooms, textbooks are an intricate part of what is involved in doing school mathematics; they also provide frameworks for what is taught, how it might be taught, and the sequence for how it could be taught. This is true in many parts of the world but is especially so in the mathematics classrooms in Brunei Darussalam where this study took place. Mathematics textbooks used in elementary and secondary schools in Brunei Darussalam are written by publishers commissioned by the Ministry of Education (MOE). The publishers follow the national curriculum and other guidelines provided by the MOE. All elementary and secondary schools in Brunei

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Darussalam have to use the mathematics textbooks recommended by the Ministry of Education.

The role of texts as a (i) source of content of lessons (Sikorova, 2012), (ii) program for teaching (Sikorova, 2012) and (iii) thorough representation of curricula (Houang, & Schmidt, 2008; Mikk, 2000) have been well documented in the literature. The analysis of TIMSS data suggests a high influence of textbooks on the teacher planning, pupil use in the classroom as well as for home work, and assessment except in Australia and New Zealand where 35% and 25% of teachers of Grade 4 pupils respectively never used the textbooks (Foxman, 1999). Foxman (1999) also suggested that teachers' greater use of textbooks may be associated with students' higher mathematics achievement as observed in Pacific Rim countries (Hong Kong, Japan and Korea; Singapore as exception). Various researchers (e.g., Fan & Kaeley, 2000; Fan, & Yan, 2007; Freeman & Porter, 1989; Stodolsky, 1989; Yan & Fan, 2006) have investigated, from different perspectives, the ways mathematics teachers use textbooks in their classroom settings: (i) their use in classroom by teachers (Fan & Kaeley, 2000; Fan, & Zhu, 2007; Zhu & Fan, 2006), (ii) their impact on students learning (Stodolsky, 1989), (iii) the quality of textbooks used in different countries (Fan & Zhu, 2007a; Parmjit 2006, 2010; Stigler, Fuson, Ham & Kim, 1986; Zhu & Fan, 2006) and (iv) the content taught in elementary schools by teachers (Freeman & Porter, 1989; Olkun & Toluk, 2003). With respect to quality of mathematics textbooks used in schools, several researchers have analysed specific content of the texts. Fan & Zhu, (2007), looked at representation of problem-solving procedures in textbooks, Parmjit (2006, 2010) looked at the distribution of addition and subtraction word problems in elementary mathematics texts, and Stigler, Fuson, Ham & Kim, (1986) compared addition and subtraction word-problems in American and Soviet elementary mathematics textbooks. What are word problems? The term 'word problem' is often used to refer to any mathematical exercise for pupils stated in a way that enhances awareness of the semantic structure of the problem in conjunction with the numerical representation (Parmjit, 2010).Word problem solving is the main focus in the teaching and learning of mathematics. Understanding mathematical procedures and solving problems are two skills that emerge naturally when the focus is on relational understanding. For pupils in early, it is not easy to model problem situations mathematically, especially contexts that involve addition and subtraction structures. Pupils who have difficulties with reading, computation or both are likely to encounter difficulties in these structures when attempting to solve word problems (Jitendra & Xin, 1997). They are unable to comprehend the semantics of these structures of the word problems and this affects the translation into mathematical symbolism.

Addition and subtraction operations and word-problems involving these operations are important content areas in the elementary mathematics curriculum. Elementary mathematics textbooks cover these topics in great detail in the first three years of elementary schooling because skills in these two areas constitute the basic building blocks for learning more advanced topics in elementary mathematics. We have seen earlier that textbooks play a critical role in helping teachers construct and reconstruct the intended curriculum into teaching units at the classroom level (Apple, 1992). Ball and Cohen (1996) and Remillard (2000) suggest that good textbooks can make significant contribution to student learning particularly when texts are well designed with appropriate examples and exercises. However if textbooks are deficient and are of poor quality, and if teachers rely on such textbooks for instruction, then it will certainly

have low impact on student learning of these basic concepts and ideas, in particular their ability to solve word problems. In spite of the prominent role that textbooks play in elementary mathematics instruction, little attention has been given to the role the quality of textbooks and curriculum materials play in student learning, especially in Brunei school settings.

In Brunei Darussalam, mathematics is taught in English from Year 1 (Elementary-1) according to National Education System for the 21st Century (SPN21). The new elementary school mathematics curriculum aims to develop in children the ability to calculate, estimate and solve mathematical problems (JPK, 2008). Teaching in Brunei is a relatively formal activity and conventional methods of teaching and learning are practiced (Zurina, 2011). In such a teaching and learning environment, mathematics textbooks and workbooks are extensively used in schools and at home. The mathematics textbooks entitled, SMART Mathematics, are published by Curriculum Development Department of the Ministry of Education. For the first three years of elementary education, there are two textbooks and two workbooks for each year. The language of texts is English as mathematics is taught in English in Brunei Darussalam. The aim of this curriculum is to foster critical thinking and problem solving skills and word problems are expected to help students achieve this aim (JPK, 2008). Since the curriculum is referred to as the 21st century curriculum, one would expect the textbooks to be superior in terms of its content, which includes addition and subtraction word problems and pedagogy. It is also expected that authors of the textbooks have taken into account recent research findings. Taking into consideration, the importance of mathematics textbooks used in classroom, coupled with the difficulty pupils face in solving word problems, especially in the concepts of additive structures, this research was design to analyse the content of addition and subtraction operators structures in the textbooks used by Bruneian Year-1, Year-2 and Year-3 pupils. This paper reports on a study that investigated the distribution of addition and subtraction word problems in Elementary 1-3 mathematics textbooks and workbooks used in Brunei Darussalam, and to determine the extent to which the distribution reflect the categories suggested by Van de Walle's (1999). More specifically, the study will seek to answer the following research questions.

1. What is the distribution of addition and subtraction word problems in Years 1-3 mathematics textbooks and workbooks?
2. To what extent do addition and subtraction word problems in Years 1-3 mathematics textbooks and workbooks reflect the 11 categories proposed by Van de Walle (1998).
3. What is the operation based distribution of addition and subtraction word problems in Years 1-3 mathematics textbooks and workbooks?

Literature Review

Addition and subtraction operations as well as word problems are important content taught during the first three years of elementary schooling. Addition and subtraction word problems are often introduced after students have mastered counting of numbers and these operations with basic numbers. Most of the addition and subtraction word problems included in lower primary curriculum consist of three parts represented by three numbers. Two of these numbers add up to the third (3 + 7 = 10; a + b = c). Depending upon the missing part in the equation and semantic structure, these problems

can be solved using addition and subtraction operations. Researchers have used the above information to classify these problems into various categories. Stigler, Fuson, Ham & Kim, (1986) used coding procedure developed by Carpenter & Moser (1984) and classified addition and subtraction word problems in primary texts from USA and USSR into 20 categories that were further organised into four groups: Change, Combine, Compare and Equalize. Riley, Greeno and Heller, (1983) and Van de Walle (1998) classified these problems into 14 and 11 categories respectively. These classifications are very similar except that the former researchers considered more complex problems including 11 categories considered by Van de Walle. Such complex problems are less suitable for lower Primary students in general and especially for students who learn these problems in a language other than their mother tongue; therefore it is more advisable to consider Van de Walls classification (see categories in Table 1) for the analysis of lower Primary textbooks. The 11 categories of word problems are divided into four groups namely Join, Separate, Compare and Part-whole. An intelligent student will be able to solve four of the eleven categories using the addition operation and the rest using subtraction operation. A good text should include sufficient number of problems from the eleven categories to provide a variety of practice examples for students. Further the problems should be sequenced in a way to promote constructivist learning.

There is considerable variation in the number of addition and subtraction word problems found in the mathematics texts used in the first three years of elementary schooling. They range from 185 to 408 word problems suggesting there is disagreement on the number of word problems that should be considered sufficient for an average learner to learn a new category of word problems (Olkun & Toluk, 2003; Parmjit, 2006, 2010; Stigler, Fuson, Ham & Kim, 1986). Stigler et al. (1986) praised the Soviet texts for accounting for all the categories of addition and subtraction word problems some of which were missing in the texts from USA, Turkey and Malaysia. Soviet texts included 20 to 29 word problems for all problem types in each of the compare and combine categories, and, for change categories 15 to 19 problems. Olkun and Toluk (2003) also expected 20 to 30 problems in each category in Turkish texts, but did not find them there. This data can be taken as a guide for deciding about the number of word problems for a category to be included in a textbook.

Students joining elementary school come equipped with some skills and strategies that they can use to solve certain type of addition and subtraction word problems**.** Therefore, the number of word problems for such categories can be decreased (Stigler, Fuson, Ham & Kim, 1986). Based on texts data, Soviet elementary students learned 15 categories of addition and subtraction word problems during Year-1 and representation of these problems in textbooks decreased from Year-1(179) through Year-2 (76) to Year-3 (20); whereas in US texts only five types of problems were covered and all these problems were not introduced during Year-1. When the total number of these problems was considered in US textbooks, a reverse trend to Soviet texts was observed; the number of word addition and subtraction problems increased significantly from Years 1 to 3. This information is useful in analysing the word problems, to decide the sequence in which the word problems may be introduced to students to promote constructivist leaning.

Analysis of elementary students' achievement data revealed that about 60% of the sample of students from USA were able to solve JRU (*joint results unknown*), SRU (*separate results unknown)*, SCU (*separate change unknown*) and PWU (*part-whole*

unknown) problems correctly (Bebout, 1990; Year-1) and SRU, SCU, CDU (*compare difference*), PPU (*part-whole part unknown*) and CLU (*compare larger unknown*) (Willis & Fuson, 1988; Year-2) whereas fewer students (about 40%) were able to solve problems in other categories. Turkish data revealed that more that 80% of Year-3 and Year-4 students were able to solve JRU, SRU, SCU, PWU and PPU categories of problems (Olkun & Toluk, 2003). Malaysian data revealed that Year-1 students' achievement on JRU, SIU (*separate initial unknown*), CLU and PWU problems was higher than other types (Parmjit, 2010); all these four categories can be solved using addition operation. Soviet texts included only a small number of JRU, JCU and JIU problems (Stigler et al., 1986). This could be due to the fact that Soviet students enter elementary school with prior skills to solve these problems. Carpenter, Ansell, Franke, Fennema and Weisbeck (1993) reported that 74% and 67% of kindergarten children could successfully solve JCU and SRU problems when taught using Cognitive Guided Instruction. Their data suggests that these students were able to solve some other complex problems too.

The variations in problem categories that students from different countries find easy to solve suggest that students from different cultures may find different sets of problems easy; of course some commonalities are expected to exist. This idea is supported by work of Gatewood (1993) whose research focused on "Intra-cultural Variability and Problem-Solving". Winerman (2006) reported cognitive differences in observation and problem solving in people different cultures. These differences are acquired by children during their formal and informal learning. According to Nisbett (2004), "People actually think about and even see the world differently because of differing ecologies, social structures, philosophies, and educational systems that date back to ancient Greece and China". Perry, Vistro -Yu, Howard, Wong and Keong (2002) reported significant differences in beliefs of primary teachers from Australia, Hong Kong, Mainland China, Philippines, Singapore and Taiwan about mathematics. These differences would not only influence their classroom teaching but also would have an impact on their children's learning in informal setting because most of them are parents too. In a broader sense, the analysis of the above data suggests that students find JRU, SRU, SCU and PWU problems easy. Students use modelling strategies to solve these problems. These data are very important for resource writers and teachers to decide the extent of emphasis they should put for a specific category of word problems during resource writing and sequencing of these problems for teaching to lower primary students.

An analysis of published research on how lower primary students solve addition and subtraction problems suggests that they use different strategies to solve addition and subtraction problems (Carpenter & Moser, 1984). For solving addition problems they use (a) direct modelling: counting all, (b) counting: counting on from first or from larger and, (c) number fact: recall or derived facts strategies. For solving subtraction problems they use (a) direct modelling: separating from, adding on and matching, and, (b) counting: counting down from and counting up from given strategies. Fennema, Levi, & Empson (1999) reported that primary students can solve JRU and PWU problem using direct modelling very early using joining-all strategy and they then move to counting followed by to number facts. They also solve SRU problems very early using direct modelling by adding but separating from first and then moving to counting down and number fact strategies.

Method

Description of texts

Year-1. Textbook 1A and Workbook 1A are divided into 10 and 11 chapters respectively. In Textbook 1A, chapters 1-3 cover Numbers, Addition and Subtraction up to 10; chapters 4-6 cover the numbers, addition and subtraction up to 20; chapters 7 and 8, numbers, addition and subtraction up to 50 and chapter 9 is mathematical thinking

and problem solving and chapter 10 is revision. The eleventh chapter in workbook 1A is mid-year practice.

Textbook 1B and Workbook 1B are divided into 7 chapters each. The first two chapters cover numbers, addition and subtraction up to 100; chapter 3 covers measurements-1 (length and weight) and chapter 4 covers measurements-2 (money and Time). Chapter 5 covers geometry; chapter 6 covers mathematical thinking and problem solving and the last chapter in Textbook 1B is Revision and in Workbook IB, end-of-year practice.

Table 1
Categorizing Additive and Subtractive Word Problems Using Van De Walle's (1998) Model

No	Category	Information	Problem
1.	JRU	*Join Result Unknown*	Hani has 12 flowers in the basket. Sarah gave her 7 more. How many flowers does Hani have altogether?
2.	JCU	*Join Change Unknown*	Nadzirah had 8 mangoes. Farah gave her some more. Now Nadzirah has 15 mangoes. How many did Farah give her?
3.	JIU	*Join Initial Unknown*	Tasha had some sweets. Aisha gave her 9 more. Now Tasha has 20 sweets. How many sweets did Tasha have at first?
4.	SRU	*Separate Result Unknown*	Azhar bought 12 pencils. He gave 5 pencils to Ranjit. How many pencils does Azhar have now?
5.	SCU	*Separate Change Unknown*	Halim catches 18 fishes. He gave some to Ali. Now Halim has 7 fishes left. How many did he give to Ali?
6.	SIU	*Separate Initial Unknown*	Anis baked some cookies. She gave 6 to Chong. Now Anis has 12 cookies left. How many cookies did Anis bake at first?
7.	CDU	*Compare Difference Unknown*	Dinesh has 13 balloons and Lina has 4 balloons. How many more balloons does Dinesh have than Lina?
8.	CLU	*Compare Larger Unknown*	Mira read 6 storybooks. Alya read 12 storybooks more than Mira. How many storybooks did Alya read?
9.	CSU	*Compare Smaller Unknown*	Azman has 4 stamps fewer than Lim. Lim has 17 stamps. How many stamps does Azman have?
10.	PWU	*Part-whole Whole Unknown*	Siti has 13 small teddy bears and 6 big teddy bears. How many teddy bears does she have altogether?
11.	PPU	*Part-whole Part Unknown*	Mimi bought 18 apples from the supermarket. 13 of them are red and the rest are green. How many green apples did Mimi buy?

(Adapted from Parmjit, 2010)

Year-2. Textbook 2A and Workbook 2A are divided into 6 and 7 chapters respectively. In both the texts the first 6 chapters cover numbers up to 1000, addition, subtraction,

measurement 1 (length; weight), multiplication-1 and division. The chapters 7 and 8 in workbook 2A cover revision and Mid-Year Practice.

Textbook 2B and Workbook 2B are divided into 8 and 9 chapters respectively. In both textbook and workbook, chapter 1 covers fractions; chapter 2 covers measurement-3 (money and time); chapter 3 covers shapes; chapter 4 covers solids; chapter 5 covers measurement-3 (Area); chapter 6 covers mathematical thinking and problem solving; chapter 7 covers statistics and chapter 8 is revision. The last chapter in workbook 2B is end-of-year practice.

Year-3. Textbook 3A and Workbook 3A are divided into 7 and 9 chapters respectively. In both textbook and workbook, chapters 1-3 covers numbers, addition and subtraction up to 10,000; chapter 4 covers geometry (shapers and solids, and, angles); chapters 5, 6, and 7 cover fractions, money and statistics respectively. Chapters 8 and 9 in workbook 3A cover revision and mid-year practice.

Textbook 3B and Workbook 3B are divided into 6 and 7 chapters respectively. In both these texts chapter 1 covers multiplication, chapter 2 division, chapter 3 length, weight and volume, chapter 4 area, chapter 5 time and chapter 6 mathematical thinking and problem solving. The last chapter in the workbook 3B is revision.

Analysis Procedure

Years 1-3 textbooks and workbooks for each grade were analysed according to the benchmark of the 11 types of standard word problems categorized by Van de Walle (1998), as shown in Table 1. The researchers independently categorized each problem in these textbooks in accordance with the given categories. In ensuring the validity of the analysis, interrater reliability was also undertaken to determine the accuracy of the analysis. Interrater reliability coefficient was 0.96. Final agreement was reached on classification of problems under disagreement before their classification to a category. A difference of 10% or more in numbers of problems in any two different categories was considered as significant. Any category that is represented by 3 or more problems in a year (9 or more over three years) was considered to be adequately represented. All word problems that could be solved using addition and subtraction of natural numbers were included, while symbolic expressions such as "8 + 7 =?" were excluded. Most of the problems dealt with whole numbers; however word problems involving currency, time and mass which involved addition and subtraction of different units and decimals were also included.

Results

The results of our analysis are divided into three sections covering (a) distribution of addition and subtraction word problems in Years 1-3 texts, (b) categories of addition and subtraction word problems in Years 1-3 texts, (c) operation based distribution of word problems in Years 1-3 texts.

Distribution of Addition and Subtraction Word Problems in Primary 1-3 Texts

The numbers of addition and subtraction word problems in textbooks (A & B) and in workbooks (A & B) as well as their total for Primary-1 to Primary-3 are reported in Table 2. There were 147 addition and subtraction word problems in Primary-1 texts (textbooks, 46 + 25 = 71 and workbooks, 44 + 32 = 76), 136 in Primary-2 texts and 106 in Primary-3 texts. Chi square analysis of overall data reveals a significant relationship

(Chi square=6.95, p=0.031) between frequency of items and grade level where number of problems decreases as grade level increases and vice versa. It implies that there is (as data in Table 2 suggest) a significant decrease in addition and subtraction word problems from Primary-1 to Primary-3. Further analysis of data using Chi square revealed that this decrease was due to decrease in these problems in textbooks only (p = 0.009), whereas a non-significant decrease was observed in workbooks (p = 0.734). A comparison of addition and subtraction word problems in textbooks and workbooks at a grade level revealed that at Primary-1 level, the numbers of addition and subtraction word problems in both textbooks and workbooks were comparable, textbook (71) and workbooks (76); Whereas at Primary-2 and Primary 3 levels the numbers of these word problems were significantly greater (>17%) in workbooks than in textbooks. The total number of these problems in textbooks for each year ranged from 39 to 71 and in workbooks from 67 to 76.

Table 2

Distribution of Addition and Subtraction Word Problems in Primary 1-3 Texts

Label	Textbooks			Workbooks			Both
	A	B	Total	A	B	Total	Total
Primary-1	46	25	71	44	32	76	147
Primary-2	33	29	62	30	44	74	136
Primary-3	17	22	39	41	26	67	106
Chi Square			9.50			0.62	6.95
p-value			0.009			0.734	0.031

Categories of Addition and Subtraction Word Problems in Year 1-3 Texts

The distribution of addition and subtraction word problems in Year-1 to Year-3 and combined (Year 1-3) into 11 categories is reported in Table 3.

Year-1. The data show that the textbooks represented only three types of problems. These are JRU (19; 26.8%), SRU (38; 53.5%), and PWU (14; 19.7%) with SRU category being the most common. Solution of JRU and PWU categories require addition operation while the SRU requires subtraction operation. Some children may also solve SRU problems using addition operation and the modelling strategy. These three categories were also the most common types in the workbooks. The word problems in workbooks can be divided into five categories: JRU, SRU, PWU, CDU and PPU as follows: 30 (39.5%), 29 (38.2%), 14 (18.4%), 1 (1.3%) and 2 (2.6%) respectively. No problems from the JCU, JIU, SCU, SIU, CLU and CSU categories were found in the texts. The Primary-1 (Textbooks and workbooks combined) do not contain examples from the remaining 6 categories of word problems.

Table 3

Categories of Addition and Subtraction Word Problems in Primary 1-3 Text and Work Books

Cate-	Primary-1			Primary-2			Primary-3			Primary 1-3		
gory	TB	WB	Total(%)	TB	WB	Total(%)	TB	WB	Total(%)	TB	WB	Total(%)
1:JRU	19	30	49 (33.3)	5	9	14 (10.3)	5	8	13 (12.3)	29	47	76(19.5)
2:JCU	0	0	0 (0.0)	0	4	4 (2.9)	2	0	2 (1.9)	2	4	6 (1.5)
3:JIU	0	0	0 (0.0)	0	4	4 (2.9)	0	0	0 (0.0)	0	4	4 (1.0)
4:SRU	38	29	67 (45.6)	9	12	21 (15.4)	3	10	13 (12.3)	50	51	101 (26.0)
5:SCU	0	0	0 (0.0)	1	3	4 (2.9)	1	0	1 (0.9)	2	3	5 (1.3)
6:SIU	0	0	0 (0.0)	1	3	4 (2.9)	2	0	2 (1.9)	3	3	6 (1.5)
7:CDU	0	1	1 (0.7)	20	11	31 (22.8)	4	7	11 (10.4)	24	19	43 (11.1)
8:CLU	0	0	0 (0.0)	2	1	3 (2.2)	0	1	1 (0.9)	2	2	4 (1.0)
9:CSU	0	0	0 (0.0)	1	1	2 (1.5)	0	2	2 (1.9)	1	3	4 (1.0)
10:PWU	14	14	28 (19.0)	17	13	30 (22.1)	14	29	43 (40.6)	45	56	101 (26.0)
11:PPU	0	2	2 (1.4)	6	13	19 (14.0)	8	10	18 (17.0)	14	25	39 (10.0)
Total	71	76	147(100)	62	74	136(100)	39	67	106 (100)	172	217	389 (100)

Year-2. Table 3 show that there were 62 addition and 74 subtraction word problems in primary-2 textbooks and workbooks. In textbooks 9 out of the 11 categories word problems were represented except for the JCU and JIU categories. However there were only 1, 1, 2 and 1 word problems from the SCU, SIU, CLU and CSU categories respectively. In the workbooks however, all the 11 categories of word problems were represented. There were 4 problems in JCU and JIU, 3 in SCU and SIU, and, 1 in CLU and CSU categories. These results show that the five categories found in the Year-1 texts were still predominant: JRU (14, 10.3%), SRU (21, 15.4%), CDU (31, 22.8%), PWU (30, 22.1%) and PPU (19, 14.0%) in the Year-2 texts. Two new categories CDU and PPU made its appearance in the Year-2 texts.

Year-3. Table 3 also shows that there were 39 and 67 addition and subtraction word problems respectively in the Year-3 texts. No word problems from the JIU, CLU and CSU were found in the Year-3 textbook. Further word problems from the JCU, SCU, and SIU categories were inadequately represented. The number of word problems from the JCU, SRU, CDU, PWU and PPU categories were 5, 3, 4, 14 and 8 problems respectively. The distribution of addition and subtraction word problems in the workbooks was slightly different. Problems from the JCU, JIU, SCU and SIU were not found in the workbooks and problems from the CLU and CSU were inadequately represented. Problems from the JRU, SRU, CDU, PWU and PPU were the most common being, 8 (11.9%), 10 (14.9), 7 (10.4), 29 (43.2) and 10 (11.9) respectively. It should be noted that these same categories were also the most common in the textbooks. The overall distribution of word problems in Years 1-3 textbooks and workbooks combined, show that five categories of word problems JRU, SRU, CDU, PWU and PPU were the most common and were adequately represented in all three years of elementary schooling. The remaining six categories were represented by 4 to 6 problems.

Table 4
Operation Based Classification of Word Problems in Primary 1-3 Texts

Grade	Addition		Subtraction	
	Number	%	Number	%
Primary-1	77	52.4	70	47.6
Primary-2	51	37.5	85	62.5
Primary-3	59	55.7	47	44.3
Total	187	48.1	202	51.9
Chi square	5.69		10.88	
p-values	0.058		0.004	

Operation Based Classification of Word Problems in Year 1-3 Texts

The data in Table 4 show the number of problems that a well-informed student will solve using addition operation as well as subtraction operation. It was decided that numbers were comparable if the difference in their percentage was 10% or less; otherwise they were different. In Year-1 texts, the number of word problems that can be solved by addition operation (77; 52.4%) and subtraction operation (70, 47.6%) were comparable. However, in Year-2 texts, problems that required the use of addition (51; 37.5%) and subtraction (85; 62.5%) operations respectively were significantly different. In the Year-3 texts 59 (55.7%) word problems can be solved using the addition operation and 47 (44.3%) can be solved using the subtraction operation. It meant that the operation based distribution of these word problems in Year-2 and Year-3 texts were significantly different. The overall total for three years suggests a comparable number of addition (187; 48.1%) and subtraction (202; 51.9 %) word problems. The chi square analysis show that the distribution of addition problems over three years was statistically non-significant (p=0.058) whereas the distribution of subtraction word problems was statistically significantly different (p=0.004).

Responses to Research Questions

Three research questions were proposed at the start of this paper. The answers to these research questions will now be presented and discussed.

1. *What is the distribution of addition and subtraction word problems in Primary 1-3 mathematics textbooks and workbooks?*

There were a total of 389 addition and subtraction word problems in Years 1-3 textbooks and workbooks. The distribution of these problems in Primary 1, Primary 2 and Primary 3 were 147, 136 and 106 respectively. These data suggest that the number of addition and subtraction word problems decreased significantly from Year-1 to Year-3. The number of addition and subtraction word problems in Year-1 to 3 textbooks and workbooks, ranged from 39 to 71 and from 67 to 76 respectively.

2. *To what extent do the addition and subtraction word problems in Primary 1-3 mathematics textbooks and workbooks reflect the 11 categories proposed by Van de Walle (1998)?*

In Year-1 texts, three categories (JRU, SRU and PWU) were adequately represented. They were 49 (JRU), 67 (SRU) and 28 (PPU) word problems. All other categories (JCU, JIU, SCU, SIU, CDU, CLU, CSU, and PPU) except for CDU and PPU were not

represented. The CDU and PPU categories were represented by 1 and 2 problems respectively. In Year-2 texts, five categories were adequately represented. These were 14 (JRU), 21 (SRU), 31 (CDU), 30 (PWU) and 19 (PPU) word problems. The other categories (JCU, JIU, SCU, SIU, CLU, and CSU) were represented by two to four problems. Interestingly, all of the 11 categories were represented in the Year-2 texts. In Year-3 texts, five categories were adequately represented: 13 (JRU), 13 (SRU), 11 (CDU), 43 (PWU) and 18 (PPU). The remaining six categories (JCU, JIU, SCU, SIU, CLU, and CSU) were inadequately represented by two or fewer problems. JIU category was not represented at all in the Year-3 texts.

Although all the 11 categories were found in the Year 1-3 texts only five categories 76 (JRU), 101 (SRU), 43 (CDU), 101 (PWU) and 39 (PPU) were adequately represented. The other categories were represented by a small number of problems: 6 (JCU), 4 (JIU), 5 (SCU), 6 (SIU), 4 (CLU) and 4 (CSU). These categories were classified as being inadequately represented.

3. *What is the process based distribution of addition and subtraction word problems in Primary 1-3 mathematics textbooks and workbooks?*

The overall data for three years show an almost equal representation of word problems that can be solved using addition (187; 48.1%) and subtractions (202; 51.9%) operations. The distribution of word problems in Year-1 texts was 77 (52.4%) for addition and 70 (47.6%) subtractions, in Year-2 texts was 51 (37.5%) for addition and 85 (62.5%) for subtraction, and, in Year-3 texts was 59 (55.7%) addition and 47 (44.3%) subtraction problems. These data were considered comparable for Year-1 and statistically significantly different for Years 2 and 3 texts.

Discussion

There were 389 addition and subtraction word problems in Bruneian Year 1-3 mathematics texts. This number is greater than 195, 234, 275 and 355 reported in texts from Turkey (Olkun & Toluk, 2003), Malaysia (Parmjit, 2006, 2010), Soviet (Stigler, et al. 1996) and USA (Stigler, et al. 1996) respectively (only one text from USA exceeded this number). The Soviet and USA texts covered 15 categories of addition and subtraction problems. The number of word problems in Years 1 to 3 mathematics texts were 147, 136 and 106 in Bruneian texts; 67, 76 and 48 in Turkish texts; 92, 120 and 22 in Malaysian texts; 179, 76 and 20 in Soviet texts and 83, 135 and 138 in US texts (average of 4 texts) respectively. An important question for consideration here is how many word problems should there be in a text for a year so that students can have adequate practice as well as not get bored with repetition of the exercises. The authors have not come across any research dealing with this question, however when we considered a publication entitled “Teaching Addition and Subtraction Word Problems to Children” by Shannon (2013), we found her suggesting 10 problems for most of the categories for a year. Olkun & Toluk (2003) have suggested between 20 – 30 word problems for each of the 11 categories. Soviet Year 1 to 3 textbooks contained 20-29 problems for separate and compare categories (Stigler, et al. 1996). The mean number of word problems from three countries (Brunei, Malaysia and Turkey) is (147+120+76)/3 = 114. This gives a number similar to that proposed by Shannon (2013) for each year that is about 10 problems per category. We believe this could be taken as a guide; which suggests that mathematics texts for a year should contain about 110 word problems in 11 categories. Hence if we need to teach these 11 categories in 3 years, the

combined total for the three years should not exceed 330 word problems. The categories can be repeated over three years as students deal with new topics such as time, money, area and so on. Since students entering elementary schools may come with skills to solve certain type of word problems (this has to be identified), the number of these problems can be adjusted depending upon what students already know and find easy to solve as reflected from data from Soviet textbooks (Stigler, et al. 1996). All texts that represent a category of word problem with more than 30 problems should be considered as over representation.

The word problem categories based on Van de Walle's model were not systematically distributed throughout Primary1, 2 and 3 mathematics texts. For each grade, SRU category is the highest representation in the mathematics text and followed by the JRU category as the second highest representation. These two categories (see Table 1 for examples) require a low level of cognitive thinking as compared to the other categories and yet they are over represented at the expense of the other categories. Findings from Parmjit (2010) revealed that both categories obtained a high percentage of correct answers in answering achievement as compared to other categories. The relationship tends to shows that pupils were generally less and more successful on the problems types that are under- and over-represented in textbooks respectively. Also pupils tended to answer incorrectly the questions from the under-represented category. Non-systematics distribution of problems in texts limits the overall development of pupil in learning the operations meaningfully (Greer, 1997; Peterson, Fennema & Carpenter, 1999). We strongly believe that the number of question for each category, according to grade level, should be balanced based on the cognitive demand the respective categories.

A well connected sequence of concepts to facilitate effective learning is highly desirable because it facilitates human information processing by decreasing cognitive load (Abiola & Dhindsa, 2012; OPSU, 2010). It is possible to follow two types of sequences: (i) introduce all the categories of problems in each grade or (ii) introduce them in stages over three years. Soviet textbooks followed first style of sequencing and represented all the categories during Primary-1 and continued reinforcing them over three years with reduced number of problems (Stigler et al., 1986). This style is not used in many other countries including Brunei, Malaysia and Turkey. We discussed earlier that in Brunei texts, only three categories were adequately represented in Year-1 and it increased to five in Year-2 and Year-3. Not all categories were adequately introduced during first year and not even over the three years. The same was true of books from Malaysia, Turkey and USA (Olkun & Toluk, 2003; Parmjit, 2004, 2010; Stigler et al., 1986). It is possible that textbook writers in these countries did not consider the 11 categories of word problems when writing the textbooks and workbooks. This finding leads us to think about advantages and disadvantages of introducing the problems in stages. According to Shannon (2013) we should teach some simple categories during first year and then keep on adding other categories as students proceed to higher grades. An advantage in this approach is that categories which are more complex than others can be introduced to more mature students in higher grades. Which categories do students find easy to learn is a question that should be explored.

Published data revealed that JRU is an easy category and CDU is difficult for students (Parmjit, 2006). Carpenter et al. (1999) reported that JRU, PWU and SRU problem types are relatively easy and that primary students during early stage can solve them using modelling strategy. Data from other countries do not reveal any clear pattern

with respect to the difficulties of word problems (see Carpenter et al., 1988; Olkun & Toluk, 2003; Parmjit, 2004, 2010; Stigler et al., 1986). There is a possibility that culture could also play a role in students' informal learning of problem solving (Guiso, Monte, Sapienza, & Zingale, 2008**).** Under such circumstances, Malaysian data will match more closely to Brunei than the data from the west.

Parmjit's (2006) study show that Year-1 Malaysian students' achievement on four categories, JRU, SIU, CLU and PWU categories was higher than the remaining seven categories. The four categories of word problems (JRU, SIU, CLU and PWU) are solved using addition operation and the remaining seven require subtraction operation. The JRU and PWU categories are very similar in structure. Therefore, teaching these two categories together will facilitate students learning by reducing four categories to three categories. This is also in line with data reported by Carpenter et al. (1999). Introducing word problems this way may be of help to teachers to guide students to recognize the 4 types of problems that need addition operation. Students once trained to identify problems that required addition operation for obtaining answer may be able to apply the same technique to other categories of word problems. The published data points toward it. For example, Turkish data suggests very inadequate representation of CSU category in Primary 1-5, whereas about responses of 68% students to this category were correct. When SIU and CLU (both can be solved using addition) are considered, they are not well represented in Turkish texts, however over 45% student responses were correct for each of these categories.

Another advantage of considering the four categories of word problems together is to avoid these problems being under represented in the texts. For example, in Brunei texts SIU and CLU categories that can be solved by addition operation were represented by only 6 and 4 problems respectively over three years. This will also help textbook writers to realize the importance of including word problems from the various problems categories.

Concluding Remarks

The researcher has emphasized the importance of textbook evaluation to improve their quality (Justi & Gilbert, 2002b; Mikk, 2000). The present study shows that in Year-1 texts in Brunei, eight categories of word problems are either not represented or inadequately represented. Only three categories (JRU, SRU and PWU) of word problems were represented with 147 problems. It shows that these three categories are over represented at the expense of other categories. Similar situations were observed in Year-2 and Year-3 texts too. It is hoped that this study will provide some invaluable insights into the quality of standard one, two and three textbooks in Brunei based on the type of word problems that are over- and under-represented. Hence the curriculum development department and textbook writers can benefit from this research to improve the quality of textbook by incorporating recent research findings in their textbooks.

More studies need to be done in Bruneian schools on the relationship between problem types and their representation. Based on previous studies, it has shown that pupils were generally less successful and more successful on the problems types that are under- and over-represented in textbooks respectively. Hence the number as well as the difficulty of questions should match the ability and maturity of pupils. It may mean that, in mathematics text of Year-1 should have higher representation number of questions for the easy categories. Then, in Year-3 of mathematics text should have higher representation number of questions for the difficult categories and lesser questions on

the easy categories. This can help pupils to develop a rich concept of addition and subtraction.

Creative teaching and learning is a popular slogan that we all are engaged in. In this research we have discussed the introduction of word problems that are solved using addition operation in Year-1 and subtraction being added in later grades. This opens another front for researchers to investigate the effectiveness of this arrangement. Moreover, some other important and valuable sequences may emerge as a result of research.

During our analysis of published data on performance on addition and subtraction problems of students from different countries to find out the word problem types they find easy to solve, we did not find an agreement in this area. We argued cultural differences could contribute to what students bring to their class when they learn these problems. Therefore a systematic international level research in this area is warranted. Moreover, Brunei should conduct this research before the textbooks are considered for revision.

Since Brunei students are learning English language and mathematics problem solving in English at the same time. It is important that vocabulary used in the textbook should match their ability. Therefore research on language aspect of textbooks is also warranted. In conclusion, Brunei Primary 1-3 texts need revisions if the curriculum goal to foster critical thinking and problem solving skills using word problems is to be achieved.

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