Simon Albin Journal of Engineering Research and Application *www.ijera.com*
ISSN : 2248-9622 Vol. 9,Issue 6 (Series -III) June 2019, pp 47-55

RESEARCH ARTICLE OPEN ACCESS

A Comparative Analysis of Word Problems in Six Junior Primary Mathematics Textbooks in Namibia

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ABSTRACT
In mid-year of 2018, while lecturing on 'Solving structured story word problems' for developing meanings of the four basic operations to the junior primary student teachers in their second year of the Bachelor Degree of Junior Primary Education at a selected Namibia's largest public University, both students and their lecturer of Numeracy Education recognized that the majority of taught story word problems found in junior primary schools' textbooks seemed to be of onetothreetypes of word problem structures, while there are actually twenty one word problem structures. This observation led the course lecturer and a student to carry out this research by analyzing the exact types of word problems found in six mathematics textbooks for Namibian junior primary schools currently in use. We analyzed by comparingtwo series of Grade 1-3 learner's books currently in use in Namibia's primary schools entitled "Platinum Mathematics" (Alves et al., 2014) and "Solid Foundations" (Burger, 2015) respectively. We analyzed by comparing two series of three textbooks and each series was written by the same authors from Grade 1-3. The literature review suggested that this focus area was under-researched in Namibia, hence its sharp contribution to the body of knowledge in particular the pedagogy of Mathematics. The key findings indicated first, inconsistency of hierarchical inclusion of word problems andsecond, multiplicative word problems were more (165) than additive word problems (108) translating into 72 multiplication word problems versus 22 word problems for addition in Table 5.1 and 67 multiplication word problems versus 21 word problems for addition as illustrated in table 5.2. The most outstanding finding showed that about 70% (188/273) word problems found in all six learner's textbooks were asking students to find the unknown results. This bias surely negatively affects students to reason realistically in Mathematics across the school grades (Ku & Sullivan, 2001) and this is supported by our teaching experience. As per our intuition, word problems and skills developed by solving word problems are the key fundamental reasoning enablers for learners to enjoy Mathematics and solve algebraic related problems in and out of school. Regrettably, this is not happening currently among Namibian learners. The new contribution to the pedagogy of Mathematics of this research study is the findings that indicated that some word problems found in junior primary school learner's books are a combination of more than one type of word problems. Hence, there is a need for teachers to ensure effective mastery of 21 word problems for the learners to be able to solve combined word problems.
Keywords: Word problems; algebra; problem solving skills; Namibia;teachers;textbooks; mathematics, and junior primary student teachers

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Date of Submission: 22-06-2019 Date Of Acceptance: 08-07-2019

I. CONTEXT OF THE STUDY AND RESEARCH PROBLEM

As per the context of teaching in Namibia and according to the course lecturer's experience as a high school teacher with a passion and record of good teaching in Mathematics in Namibia, the majority of teachers do not see the link between word problems in primary school and algebraic word problems in high school. This gap affects the way teachers help learners to make connections in Mathematics and within Mathematics. Algebra frustrates most learners in schools if they are not equipped to think algebraically and it affects their social and academic wellbeing while at school. Ku and Sullivan (2001) explicitly explain the main causes of difficulties this way:

> [Research] indicate[d] that mathematics word problems are difficult for students at all age levels in elementary and secondary schools. A major cause of the difficulty appears to be the students' inability to convert the problems into the math operations that must be performed to solve them. Some researchers have also noted that lack of familiarity with word problem structures may also contribute to poor student performance. (p. 3)

Ku and Sullivan's (2001) expression agrees with Weaver and Kintsch (1988) who

indicate that "word algebra problems are hard even for teachers and students good at Mathematics" (p .2). With this background, the course lecturer found it fit to create awareness among teachers of Mathematics so that they can start to make connections between the algebra taught in primary school and algebra taught in high school in order to be in a position to equip their learners with the necessary mathematical thinking skills of problem solving. Problem solving isa key skill in Mathematics and a skill that everyone needs in their everyday life. Adiguzel and Arpinar (2004) suggest strongly that "the real purpose of learning Mathematics is to solve problems" (p. 1). Hence the value of the significance of these research findings, in that teachers will be informed of the shortcomings of textbooks and be encouraged to plan and teach word problems consistently, sufficiently and appropriately.

II. LITERATURE REVIEW

The literature review indicated that research of the focus area of this study was limited especially in Namibia. However, in developed countries like the U.S., Japan, Russia and UK, there is ongoing research. For instance, research from America indicated that American students found some word problems more difficult than others (Grishchenko, 2009; Garcia, Jimenez, & Hess, 2006; Stern, 1993; Riley & Green, 1988). The same literature indicated that performance of students solving word problems was limited due to limited exposure to types of problems found in school arithmetic textbooks (Grishchenko, 2009; Tornroos, 2004; Fujita & Jones, 2003; Haggarty & Pepin, 2003; Cai, Lo, & Watanabe, 2002). "Textbooks' comparative analysis in the U.S and Russia showed that word problems were similar in content and numbers" (Grishchenko, 2009, p. ix). There was also an imbalance of distribution of word problems in the U.S. and their students found solving word problems more difficult than computational problems (Grishchenko, 2009).

The mastery of solving word problems is so important. Word problems are relational as they "describe relational dependencies between everyday objects" (Grishchenko, 2009, p. 4). Checkley (2006) expresses this relational dependency explicitly indicating that "achievement in Algebra in high school … depends on students learning to think algebraically in earlier grades" (p. 16). In the year 2000, the National Council of Teachers of Mathematics (NCTM) after adopting Principles and Standards for School Mathematics, chose enhancing of students' problem solving abilities as the central goal of mathematics education (NCTM, 2000). NCTM (2000) strongly recommended mathematics textbooks to be enablers of developing students' natural inclination to solve problems and acquire problem solving skills. In addition, "research has shown that textbooks make a big difference to the quality of teaching" (Grishchenko, 2009, p. 7). Textbooks "can offer well-structured material that keeps the teachers' attention on what matters, allows children to work at their own pace, and provide an opportunity for their mental engagement with the subject" (Newton & Newton, 2006, p. 71). The Namibia's Ministry of Education, Arts and Culture also emphasized the importance of learner's books to exemplify mathematical problems in a context that is meaningful to the learners and continuously develop by reinforcing the relationships between concepts and topics throughout the four school phases (Namibia. Ministry of Education, Arts and Culture, 2016).Hence, the importance of this research by comparing and analyzing content of textbooks to help our teachers and learners enjoy the fun power of solving mathematical word problems in and out of school.

III. RESEARCH GOAL AND QUESTIONS

The goal of this research was to compare and analysethetypes of word problems found in the "Platinum Mathematics" and "Solid Foundations Mathematics" Grade 1-3 learner's books in Namibia. In order to attain this research goal, the study needed to answer the following research question:

What is the trend of word problems found in the "Platinum mathematics" and "Solid Foundations Mathematics" Grade 1-3learner's books in Namibia?

IV. METHODOLOGY AND ANALYTICAL FRAMEWORK

a. Research design

This research study was quantitative in nature and was grounded within the interpretive paradigm as researchers are expected to make meaning out ofnumerical data (Bertram & Christiansen, 2015; Maree, 2015) aspresented in Tables 5.1-5.3.

b. Sample and sampling method

We analyzed two series of three junior primary mathematics textbooks and each series is of the same type written by the same authors for Grade 1-3 in Namibia. The books were selected because they are currently in use as junior primary mathematics learner's textbooks in Namibia.

c. Data analysis

Initially, we applied inductive content analysis by tabulating word problems indicating the types and textbook page numbers for every word problem. Later, we tallied the types of word problems to obtain the frequency of the word problems. The findings are presented in Tables 5.1-5.3.

d. Ethical considerations

We selected the"Platinum Mathematics" textbooks and "Solid Foundations Mathematics" because they are currently in use byNamibia'sjunior primary schools. The selection and analysis of these textbooks was done for research purpose only and not to attack or discourage any of the authors. Finally, we would like to thank the authors of "Platinum mathematics" and "Solid Foundations Mathematics" learner's textbooks for their hard work in writing colorful and good textbooks for our Namibian junior primary learners. We are very proud of you. We also trust that all textbook authors would learn from the findings of this study in order to upgrade the quality of content with regards to word problems in learner's textbooks.

e. Analytical framework

Here are the two tables for additive and multiplicative word problems which aided researchers in analyzing the textbooks' content:

Table 4.1: Additive word problem structures (Adapted from Math Matters, Grades K-6, Math Solutions Publications)

PROBLEM TYPE			
Join	*Result Unknown* Laina had four dolls. She bought two more. How many dolls does she have now? $4 + 2 = \square$	*Change Unknown* Laina had four dolls. She bought some more dolls. Now she has six dolls. How many dolls did Laina buy? $4 + \square = 6$	*Initial Quantity Unknown* Laina had some dolls. She bought two more dolls. Now she has six dolls. How many dolls did Laina have before she bought some more? $\square + 2 = 6$
Separate	*Result Unknown* Rodney had ten cookies. He ate three cookies. How many cookies does Rodney have left? $10 - 3 = \square$	*Change Unknown* Rodney had ten cookies. He ate some of the cookies. Now he has seven cookies left. How many cookies did Rodney eat? $10 - \square = 7$	*Initial Quantity Unknown* Rodney had some cookies. He ate three cookies. Now he has seven cookies left. How many cookies did Rodney have to start with? $\square - 3 = 7$
Part-Part-Whole	*Whole Unknown* Five boys and three girls are on the basketball team. How many children are on the basketball team? $5 + 3 = \square$	*Part Unknown* Eight children are on the basketball team. Five are boys and the rest are girls. How many girls are on the basketball team? $5 + \square = 8$	
Compare	*Difference Unknown* Ahmed has two brothers. Christine has three brothers. Christine has how many more brothers than Ahmed? $3 - 2 = \square$ or $2 + \square = 3$	*Larger Quantity Unknown* Ahmed has two brothers. Christine has one more brother than Ahmed. How many brothers does Christine have? $2 + 1 = \square$	*Smaller Quantity Unknown* Christine has one more brother than Ahmed. Christine has three brothers. How many brothers does Ahmed have? $\square + 1 = 3$ or $3 - \square = 1$

Table 4.2: Multiplicative word problem structures (Adapted from Math Matters, Grades K-6, Math Solutions Publications)

Equal Groups	Whole Unknown (Multiplication)	Size of Groups Unknown (Partition Division)	Number of Groups Unknown (Measurement Division)
	Markus has 4 bags of apples. There are 6 apples in each bag. How many apples does Markus have altogether?	Markus has 24 apples. He want to share them equally among his 4 friends. How many apples will each friend receive?	Markus has 24 apples. He put them into bags containing 6 apples each. How many bags did Markus use?
Comparison	Product Unknown (Multiplication)	Set Size Unknown (Partition Division)	Multiplier Unknown (Measurement Division)
	Julie picked 6 apples. Markus picked 4 times as many apples as Julie. How many apples did Markus pick?	Markus picked 24 apples. He picked 4 times as many apples as Julie. How many apples did Julie pick?	Markus picked 24 apples, and Julie picked only 6. How many times as many apples did Markus pick as Julie did?
Area	Unknown Product	Group Size Unknown	Number of Groups Unknown
	There are 3 rows of apples with 6 apples in each row. How many apples are there?	If 18 apples are arranged into 3 equal rows, how many apples will be in each row?	If 18 apples are arranged into equal rows of 6 apples, how many rows will there be?
Combinations	Product Unknown		
	Sam bought 4 pants of shoes and 3 jackets, and they all can be worn together. How many different outfits consisting of a pair of pants and a jacket does Sam have?		

V. RESULTS

Tables 5.1-5.3show our statistics of word problems in all six textbooks. The tables show the frequency for each type in every grade for all 21 word problems.

Here are the keys important to interpret Tables 5.1-5.3 appropriately:

- All multiplicative word problems have a yellow thick line along the left-hand side of Tables 5.1-5.3;
- Additive word problems do not show a yellow line beside them;
- EGWU+JRU = equal groups whole unknown and join result unknown word problems;
- EGWU+SRU = equal groups whole unknown and separate result unknown word problems;
- (J+S)RU = join result unknown and separate result unknown word problems;
- JRU+PPWPU = join result unknown and part-part whole part-unknown word problems;
- (SC+JR)U = separate change unknown and join result unknown.

Table 5.1: Frequency distribution of word problem structures in all three Platinum Mathematics Learner's textbooks per grade

Word problem structures: Analysis of Platinum Mathematics Learner's books Grade 1-3						
Grades	Join	Result unknown	Change unknown	Initial Quantity unknown	**Total**	**Grade total**
1		6			**6**	**22**
2		9			**9**	
3		7			**7**	
	Separate					
1		12			**12**	**35**
2		7			**7**	
3		16			**16**	
	Compare					**0**
1						
2						
3						
	Part-part whole	Whole unknown	Part unknown			
1			1		**1**	**7**
2			2		**2**	
3		1	3		**4**	
	Equal groups	Product unknown	GS unknown	NG unknown		
1		3	8		**11**	**72**
2		17	10	5	**32**	
3		17	9	3	**29**	
	Comparison					
1						**2**
2		2			**2**	
3						
	Area					
1						**11**
2		4	3		**7**	
3		1	2	1	**4**	
	Combinations	Product unknown				
1						**0**
2						
3						
Arising word problems: Combinations of more than one type of word problem structure						
2	EGWU+JRU	1			**1**	**8**
1	EGWU+SRU	2			**2**	
2 & 3	(J+S)RU	4			**4**	
2	JRU+PPWPU	1			**1**	
Grand total		**110**	**38**	**9**	**157**	**157**

Table 5.2: Frequency distribution of word problem structures in all three Solid Foundations Learner's textbooks per grade

Word problem structures: Analysis of Solid Foundations Mathematics Learner's books Grade 1-3						
Grades	**Join**	**Result unknown**	**Change unknown**	**Initial Quantity unknown**	**Total**	**Grade total**
1		**4**			**4**	**21**
2		**13**			**13**	
3		**3**	**1**		**4**	
	Separate					
1		**1**			**1**	**18**
2		**12**	**1**		**13**	
3			**3**	**1**	**4**	
	Compare		**Smaller quantity**	**Larger quantity**		
1				**1**	**1**	**1**
2						
3						
	Part-part whole	**Whole unknown**	**Part unknown**			
1						**4**
2		**1**	**2**		**3**	
3			**1**		**1**	
	Equal groups	**Product unknown**	**GS unknown**	**NG unknown**		
1		**9**	**1**	**2**	**12**	**67**
2		**16**	**5**	**11**	**32**	
3		**14**	**7**	**2**	**23**	
	Comparison					
1						**3**
2		**3**			**3**	
3						
	Area					
1						**1**
2		**1**			**1**	
3						
	Combinations	**Product unknown**				
1						
2						
3						
New combined word problems: Combinations of more than one type of word problem structure						
3	**(SC+JR)U**	**1**			**1**	**1**
Grand total		**78**	**21**	**17**	**116**	**116**

Table 5.3: A comparative frequency distribution of word problem structures in all three Solid Foundations vs three Platinum Mathematics Learners' textbooks

Word problem structures	Platinum Mathematics	Solid Foundations	Difference	Total	Total %	Additive word problems	Additive word problems %
Join	22	21	1	43	15.75%	108	39.56%
Separate	35	18	17	53	19.41%		
Compare	0	1	1	1	0.37%		
Part-part whole	7	4	3	11	4.03%	Multiplicative word problems	Multiplicative word problems %
Equal groups	72	67	5	139	50.92%	165	60.44%
Comparison	2	3	1	5	1.82%		
Area	11	1	10	12	4.40%		
Combinations	0	0	0	0	0%		
New combined word problems	8	1	7	9	3.30%		
Total				273	100%	273	100%

VI. DISCUSSIONS

The frequency distribution of numerical data in Tables 5.1-5.3 suggested three themes which are discussed here:

6.1 Inconsistency of word problems

There was no pattern in Tables 5.1-5.3that showed a fair distribution of word problems. For instance, Table 5.3 shows there was no word problem found in all six learner's books relating to combination word problems. Table 5.3 also shows that there were less than 5 word problems in all six learner's books relating to compare or comparison word problems. However, there were 72 equal groups word problems compared to 22 join word problems in Table 5.1 and in table 5.2 shows that there were 67 equal groups word problems compared to 21 join word problems. In Table 5.3, the abovementioned statistics translates into 139 equal groups word problems compared to 43 join word problems. Table 5.3 shows that 39.56% (108/273) of word problems in all six learner's books were additive word problems versus 60.44% (165/273) of multiplicative word problems. One would expect to find that the number of join word problems and additive word problems to be either equal to or more than equal groups word problems or multiplicative word problems. Hence, there was bias in distribution of word problems and this concurred with the suggestions of Grishchenko (2009).

6.2. About 70% of word problems were of one format –'unknown results'

The findings in Table 5.1 showed that 110 word problems out of 157 problems asked students to find the unknown result which is 70% of story word problems in Table 5.1. The findings in Table 5.2 showed that 78 word problems out of 116 problems asked students to find the unknown result which is 67% of story word problems in Table 5.2. This translates into an average of 69% (188/273) of story word problems finding the unknown results in all six learner's books. This dominance has serious limitations for children's development of mathematical thinking powers. First, it gives students an impression that an equal sign always means finding an answer instead of a balanced equation. Second, it does not afford students the opportunity to explore number bonds of numbers and hence limits students' mathematics thinking powers or habits of minds, to name a few: flexibility, generalizations, experimentation, exploration, sequencing, probing, and testing of math ideas. This lack of understanding in students leads to lack of skills, knowledge, and interest in the subject and eventually poor performance. This study confirmed that performance and exposure of students to word problems found in school arithmetic textbooks was indeed regrettably limited (Grishchenko, 2009; Tornroos, 2004; Fujita & Jones, 2003; Haggarty & Pepin, 2003; CAI& Watanabe, 2002).

6.3 Some word problems are a combination of more than one type

This paper made a new discovery and contribution to literature: some of the textbooks' word problems were a combination of more than one type of word problem. Table 5.1 showed that eight out of 157 problems were a combination of two types of word problems while Table 5.2 showed that one out of 116 problems was a combination of two types of word problems. With this inconsistency of inclusion of word problems, we expect learners to find solving these combined word problems more difficult.

VII. CONCLUSIONS

The key findings indicated first, inconsistency of hierarchical inclusion of word problems and second, multiplicative word problems were more (165) than additive word problems (108) translating into 72 multiplication word problems versus 22 word problems for addition as illustrated in Table 5.1 and 67 multiplication word problems versus 21 word problems for addition as illustrated in Table 5.2. The most outstanding finding showed that about 70% (188/273) word problems found in all six learner's textbooks were asking students to find the unknown result. This bias surely negatively affects students in reasoning realistically in Mathematics across the school grades and this is supported by our teaching experience. In addition, findings indicated that some word problems found in school textbooks were a combination of more than one type of word problem.

VIII. RECOMMENDATIONS

Based on the findings above, this study would make two recommendations. First, textbook writers and future textbook writers, including in-service teachers, should consider the hierarchy and inclusion of all types of word problem structures as per the framework. This change is expected to contribute positively to mathematics learners' abilities to reason and think mathematically as well as algebraically in particular. Second, mathematics teachers should be aware that some word problems found in school textbooks are a combination of more than one type of word problem. In order to help learners to solve combined word problems, teachers should teach well and ensure themastery of all 21 word problem structures.

REFERENCES

[1]. Adiguzel, T., & Akpinar, Y. (2004). Improving school children's mathematical word problem solving skills through computer-based multiple representations. Retrieved February 7, 2018, from https://www.learntechlib.org/p/76930/

[2]. Alves, M., Courtney-Clarke, M., du Preez, K., van der Westhuizen, G., & Whittemore, K. (2014). Platinum Mathematics Grade 1 Learner's Book. Cape Town: CTP Printers.

[3]. Alves, M., Courtney-Clarke, M., du Preez, K., van der Westhuizen, G., & Whittemore, K. (2014). Platinum Mathematics Grade 2 Learner's Book. Cape Town: CTP Printers.

[4]. Alves, M., Courtney-Clarke, M., du Preez, K., van der Westhuizen, G., & Whittemore, K. (2014). Platinum Mathematics Grade 3 Learner's Book. Cape Town: CTP Printers.

[5]. Bertram, C., & Christiansen, I. (2015). Understanding research. Pretoria: Van Schaik.

[6]. Burger, M. (2015). Solid foundations Mathematics Learner's book Grade 1. Windhoek: Namibia Publishing House (Pty) Ltd.

[7]. Burger, M. (2015). Solid foundations Mathematics Learner's book Grade 2. Windhoek: Namibia Publishing House (Pty) Ltd.

[8]. Burger, M. (2015). Solid foundations Mathematics Learner's book Grade 3. Windhoek: Namibia Publishing House (Pty) Ltd.

[9]. Cai, J., Lo, J. J., & Watanabe, T. (2002). Intended treatment of arithmetic average in U.S. and Asian school mathematics textbooks. School Science and Mathematics, 102(8), 391-404.

[10]. Checkley, K. (2006). The essentials of mathematics K-6: Effective curriculum, instruction and assessment. Alexandria, VI: Association for supervision and curriculum development.

[11]. Fujita, T., & Jones, K. (2003, September). Interpretations of national curricula: The case of geometry in popular textbooks in Japan and the UK. Paper presented at the British Educational Research Association Annual Conference, Heriot-Watt University, Edinburgh, UK.

[12]. Garcia, A., Jimenez, J., &Hess, S. (2006). Solving arithmetic word problems: An analysis of classification as a function of difficulty in children with and without arithmetic LD. Journal of Learning Disabilities, 39(3),270-281.

[13]. Grishchenko, S. (2009). A comparative analysis of word problems in selected United States and Russian first grade textbooks. Santa Barbara: ProQuest Dissertations Publishing, University of California.

[14]. Haggarty, L., & Pepin, B. (2002). An investigation of mathematics textbooks and their use in English, French and German classrooms: who gets an opportunity to learn what? Oxford, UK: Westminster Institute of Education.
[15]. Ku, H. Y., & Sullivan, H. J. (2000). Personalization of mathematics word problems inTaiwan. Educational Technology Research and Development, 48(3), 49-59.
[16]. Maree, K. (Ed.). (2015). First steps in research. Pretoria: Van Schaik.
[17]. Namibia. Ministry of education, Arts and Culture. (2016). Mathematics syllabus Grade 8-9: Junior secondary phase. Okahandja: NIED.
[18]. National Council of Teachers of Mathematics (NCTM). (2000). Principles and standards for school mathematics. Reston, VA: The Author.
[19]. Newton, D. P., & Newton, L. D. (2006). Could elementary mathematics textbooks help give attention to reasons in the classroom? Educational Studies in Mathematics, 64, 69-84.
[20]. Riley, M. S., & Green, J. G. (1988). Developmental analysis of understanding language about quantities and of solving problems. Cognition and Instruction, 5, 49-101.
[21]. Stern, E. (1993). What makes certain arithmetic word problems so difficult for children? Journal of Educational Psychology, 85(1),7-23.
[22]. Tornroos, J. (2004, July). Mathematics textbooks, opportunity to learn and achievements. A paper accepted for discussion in 10th International Congress of Mathematics Education. Copenhagen, Denmark, 4-11 July 2004.
[23]. Weaver, C. A., & Kintsch, W. (1988). The conceptual structure of word algebraproblems. University of Colorado, Institute of Cognitive Science.

Simon Albin" AComparative Analysis of Word Problems in Six Junior Primary MathematicsTextbooks in Namibia"International Journal of Engineering Research and Applications (IJERA), Vol. 09, No.06, 2019, pp. 47-55