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Examination of mathematical opportunities afforded to learners in grade 1 Malawian primary mathematics textbooks

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This paper present findings from a study which aimed at examining mathematical opportunities available in Malawian grade 1 textbook and their ability to enhance learners' understanding of number concept through outcome based education (OBE). Two elements (examples and tasks) of the Mathematics Discourse in Instructional analytic framework for Textbook Analysis (MDITx) were used to guide analysis of the textbook. The results show that the textbook has provided learners with mathematical opportunities to understand the number concept using different levels of examples which are presented with real life graphics. However, lack of variety in terms of the tasks provided in the textbooks is viewed as a limiting factor to enhancing learners' understanding of number concepts through independent practice and critical thinking, hence not achieving some of the goals of OBE.

Keywords: Mathematics textbook, number concept, examples, tasks, outcome based education.

Introduction and background.

The results of Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) show that Malawian pupils consistently perform very poorly on primary mathematics especially in number concept and operations (SACMEQ, 2011). For example SACMEQ 1 and 3 project results showed that Malawian grade 6 learners achieved poorly in numeracy, specifically in number concept and operation as compared to the other Southern African Countries (SACMEQ, 2011). Kasoka, Jacobsen and Kazima (2017) bemoans the Malawi SACMEQ results as worrisome because number concept and operations define numeracy. This implies that it might be difficult for Malawi to improve numeracy levels which are very low among its citizens if the causes of learners' inability to understand number concept and operation are not addressed.

As one way of addressing the problem of learners' low achievements in mathematics and science, the Government of Malawi through the ministry of education proposed a shift from objective education model (OEM) to outcome based education model (OBE). The underlying argument for the shift was that OEM was teacher centred, hence teacher played a more active role in achieving learning objectives than the learners. As such, OBE was assumed to be a major solution to improving and promoting learners' active participation and performance in all school subjects including mathematics (Malawi Institute of Education [MIE], 2006). The Malawi OBE curriculum emphasises learners' achievement through active participation in classroom and out of classroom activities which promote independent learning and critical thinking. In OBE, the content and focus of the curriculum determines the content and structure of curriculum material including textbooks, hence the value of a textbook is determined by the degree to which it contributes to students' achievement of the learning outcomes (Chang & Salalahi, 2017). This means that the goals of OBE curriculum are expected to be highlighted and achieved through the textbook. As Fujita, Jones and Kunimune (2009) argue, textbooks constitute much to curriculum implementation, hence they are

widely used due to their potential in mediating between the intended and the implemented curriculum. This implies that studying of textbooks is important because of their influence to both teachers and learners. However, since the implementation of OBE curriculum in Malawian primary education, no study has been conducted to analyse the content of the textbooks and their affordances in learners' achievement of the learning outcomes and OBE goals. As such, the purpose of this study was to analyse the effectiveness of the content of grade 1 primary mathematics textbooks in helping the learners to achieve intended learning outcomes. Specifically, the study aimed to answer the following questions:

1. What opportunities are available for Malawian grade 1 learners to learn number concept from primary school mathematics textbook?
2. How do opportunities to learn number concept in the textbooks relate to the goals of outcome based education curriculum?

This study is timely in Malawian context for effective achievement of OBE curriculum goals. The study also makes relevant contribution to global literature on textbooks as there are fewer topic specific studies on mathematics textbooks analysis (Chang & Salalahi, 2017).

Theoretical framework

Ronda and Adler (2016) proposed a framework for analysing mathematics textbooks which is known as Mathematics Discourse in Instructional analytic framework for Textbook analysis (MDITx). The MDITx tool was adapted from Mathematical Discourse in Instruction (MDI) framework which was developed to analyse opportunities available for learners to learn mathematics (Ronda & Adler, 2016). MDITx is rooted from the sociocultural perspective that foregrounds the importance of mathematics in a coherent manner. MDITx comprises of five key elements; object of learning, examples, tasks, naming/word use and legitimations. The object of learning is the main focus of the lesson (Adler & Ronda, 2015). The object of learning might contain the key content (mathematical concept) as well as the expected capability (like simplifying, solving or proving). Examples are particular case of a larger class used for drawing reasoning and generalisations (Ronda & Adler, 2016). Learners' textbooks are expected to contain examples which would enable learners to attend to understand a particular object of learning. The examples might be worked (to illustrate the procedure), or not worked (as learners' exercise). Tasks are what learners are asked to do with the examples like solving or drawing (Ronda & Adler, 2016). Different examples and tasks offer learners different opportunities to learn mathematics. Naming/word use is the way of naming mathematical concepts and procedures. Ronda and Adler (2016) argue that the way we name mathematical concepts and procedures might affect learners' focus during the lesson. Legitimations are the mathematical concepts and mathematical criteria communicated to legitimise or justify key moves or steps in a procedure.

Analysis of the textbooks focused on two elements of MDITx which are examples and tasks. The study focused on examples and tasks because it is commonly assumed that examples and tasks play a central role in the development of mathematics as a discipline (Olteanu, 2018). The second reason for choosing examples and tasks was that at this level, the learners have not reached the level of reading, as such, there would be little naming/word use and legitimation in the grade 1 textbook.

MDITx framework was suitable for analysing number and operations topic because its elements are similar to characteristics of OBE. As already explained, OBE emphasises on achievement of learning outcomes and measures the learners' achievement using examples and tasks. Furthermore, OBE defines learning outcomes as what learners are supposed to learn. This definition is similar to that of object of learning in the MDITx framework.

Methodology

I analysed grade 1 mathematics textbook for learners by the Malawi Institute of Education publisher. This is the only textbook available for use by Malawian grade 1 learners. The minimum age for grade 1 learners in Malawi is 6 years. According to the OBE mathematics curriculum, learning outcomes for the units of number and operation in grade 1 are; count up to 9, identify and write numbers up to 9, add numbers with sum not exceeding 9, subtracting of numbers within the range of 0 to 9, apply number concept in daily life. In my textbook analysis, I only focused on Unit 1 and Unit 4 which are about counting and writing of numbers 0 to 9. This is because ability to count and write these numbers is a foundation for understanding other mathematical operations. As Aunio and Niemivirta (2010) argues, learners understanding of number concept is very important in the learning of mathematics, hence learners without sound understanding of number concept skills struggle to excel in learning mathematics. Table 1 presents a summary of the codes that I used to analyse the examples and the tasks as adapted from Ronda and Adler (2016).

Examples	Tasks
Level 1-at least one of the pattern of variation (C-Contrast, G-Generalisation, F-Fusion).	Level 1-carry out the known procedure or use known concepts related to the object of learning (KPF only).
Level 2- any two of C, G, or F	Level 2-carry out procedures involving the object of learning (includes current topic procedure-CTP).
Level 3-all the patterns of variations.	Level 3-Carry out level 2 tasks plus tasks that involve multiple concepts and connections (includes CTP and Application/making connections-AMC)

Table 1: codes for analysing textbook examples and tasks

Example space belonged to Level 1 if only one pattern of variation is used throughout (the examples were the same), or Level 2 if there was contrasting (there was variations which signified two aspects of object of learning), or Level 3 if there was fusion of more than one aspect of the object of learning (single pattern as well as contrasting examples present). A task belonged to Level 1 if it only involved Known Procedure Facts (KPF) from previously learned knowledge, or to Level 2 if it involved the current topic procedure (CTP) or required learners to apply the procedure that is being introduced in the current lesson, or to Level 3 if it included the current topic procedure as well as Applications/ Making Connections (AMC) among different concepts.

Results and discussion

Table 2 presents a summary of the findings from analysis of the examples and tasks from unit 1 to unit 4 of the grade 1 learners' mathematics textbook.

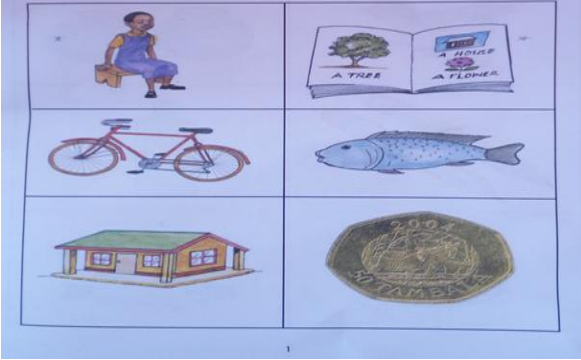
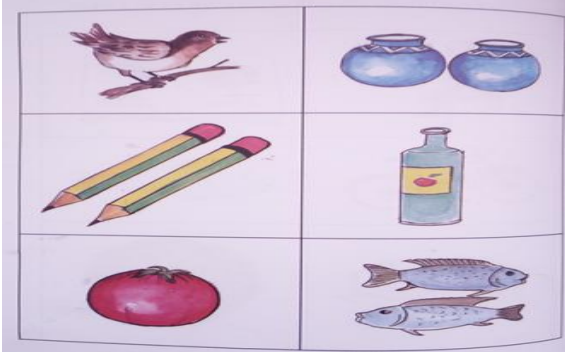
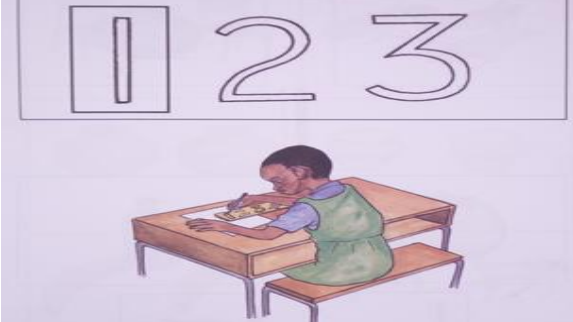
Unit	Object of learning	Examples	Tasks
1	Counting and writing numbers up to 5 (25 example spaces)	G (11 example spaces) C (8 example spaces) F (6 example spaces)	KPF (5 tasks) CTP (18 tasks) AMC (2 tasks)
4	Counting and writing numbers up to 9 (15 example spaces)	G (6 example spaces) C (4 example spaces) F (5 example spaces)	KPF (4 tasks) CTP (9 tasks) AMC (2 tasks)
	Legend	G: generalisation C: Contrast F: Fusion	KPF: Known procedure and facts CT: Current topic and Procedures AMC: Application/making connections

Table 2: summary of nature of examples and tasks in grade 1 learners' mathematics textbook

Column 1 indicates textbook units where learners are introduced to number concept in the grade 1 learners' textbook. Column 2 indicates the objects of learning under each of these units. Column 3 indicates codes assigned to example spaces under each unit. Column 4 indicates the codes assigned to learners' tasks against each unit. The table shows that out of the 40 example spaces, 17 example spaces belonged to level 1 (G) as they required same ways of either counting or identifying numbers. This implies that more examples leaned toward generality of numbers through noticing of similarity. 12 examples belonged to level 2 (C) as they required different demands like identifying what a particular number concept is and what it is not. 11 example spaces belonged to level 3 (F) because they contained examples which required understanding of different learning outcomes like counting, identifying numbers and writing numbers. This implies that most example spaces contained one pattern of variation (generalisation or contrasting) and few had a combination of different patterns of variation (fusion). This means that the textbook offers few opportunities for learners to achieve several outcomes in a single example space.

Analysis of the tasks showed that out of the 40 tasks, 27 tasks were under CTP as they required learners to use knowledge of the number concept that was being learnt. 9 tasks were under KPF as they required learners to use their previous knowledge of counting. 4 tasks were under AMC as they involved comparing the magnitude of different numbers (ordering of numbers in either ascending or

descending order). This shows that the 2 units mainly contained level 2 (CTP) tasks. This implies that most of the tasks aimed at mediating learners' capabilities with respect to the current topic (Ronda & Adler, 2016). Table 3 present figures which show example spaces and tasks presented in the textbook with an aim of mediating meaning of number 1 concept.

Example space	Description of the task
 <p data-bbox="268 869 726 902">Figure 1: counting number of objects</p>	<p data-bbox="869 488 1364 521">Count the number of objects in each box.</p>
 <p data-bbox="231 1299 762 1332">Figure 2: identifying of boxes with 1 object</p>	<p data-bbox="869 925 1284 958">Identify boxes containing 1 object.</p>
 <p data-bbox="231 1709 762 1742">Figure 3: drawing number 1 using a model</p>	<p data-bbox="869 1364 1276 1397">Drawing number 1 using a model.</p>

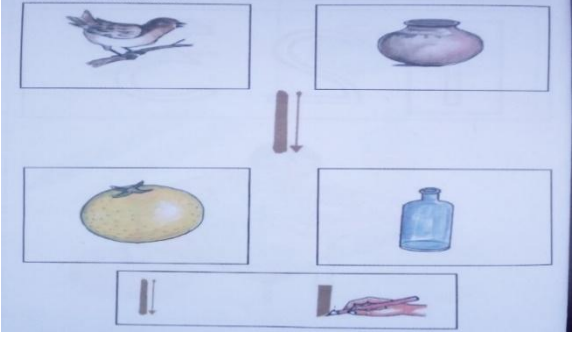
	<p>Counting and writing the number of objects in each box</p>
<p>Figure 4: counting and writing number 1</p>	

Table 3: examples spaces and tasks

Discussion on the example spaces

The figures in table 3 provide a general layout on example spaces and tasks provided in units 1 and 4 of the textbook. These are the units which introduce learners to number concepts from 0 to 9. The task and the object of learning for learners textbooks for grade 1 to 4 are in local language as per the education system in Malawi. The study found that both units introduced the numbers in a similar manner. Firstly, each unit started with an example space for counting of objects. Secondly the unit presented an example space for identifying objects of a specific number. Thirdly the unit presented an example space for drawing number 1 using drawing materials. Lastly the unit presented example space for counting and writing number of objects.

I coded example space in figure 1 under generalisation (G) because there is one object in each box, hence representing number 1. As such the examples in figure 1 were coded under generalisation because they enable learners to generalise that number 1 represent single object. This also implies that the example space only focused on single outcome of counting number of objects, hence it is at low level (level 1). I coded example space in figure 2 under contrasting (C) because there are different numbers of objects in each box. This means that the learner has to make similarities and contrasts between or among number and objects when identifying boxes containing only 1 object. In so doing the learners understand the difference between objects used to represent the number 1 and those which do not represent the number 1. This shows that example space in figure 2 is at medium level (level 2). I coded an example in figure 3 under G because it was only about drawing a number 1. This means that the aim of the example in figure 3 was to help learners to have a general picture of how the number 1 can be drawn. As such the example in figure 3 is at low level (level 1). I coded example space in figure 4 under Fusion (F) because it contained 2 learning outcomes which are counting number of objects and writing number 1. This means that the example space in figure 4 is at higher level (level 3).

I found that example spaces in units 1 and 4 provided learners with opportunities to understand number concepts properly because they mediate the learning outcome and real life visual features. For example, example spaces in figures 1, 2 and 4 contain pictures of a girl, book, bicycle, fish, house, money, tomato, pencil and so on. These are real like features which are familiar and used by the learners in their daily life. This implies that these features would enhance learners' understanding of the number concept. Therefore the most important feature in both units of the

textbook is that they are dominated by real life graphics, hence they can help the learners to understand the number concepts. As Olteanu (2018) argues, learners' understanding of mathematical concepts is visually mediated through diagrams, graphs, and drawings.

Discussion on the tasks

The learning outcome for figure 1 task is counting number 1, and the accompanying task is about counting the number of objects in each box. I coded this task under current topic procedures (CTP) because it is mainly related to the current learning outcome. The learning outcome for figure 2 is identifying number 1 concept and the accompanying task is to identify boxes containing 1 object. I coded this task under applications/making connections as it offers learners opportunities to further understand the number 1 concept through making of judgment about what it should contain and what it should not contain. The task for figure 2 also offer learners opportunities to justify their choices regarding the chosen boxes in relation to those that are not chosen. The learning outcome for figure 3 is drawing number 1 and the accompanying task is to draw number 1 using a drawing number pattern tool. I coded the task in figure 3 under CTP because it mediates learners' capabilities in writing or representing number 1 concept symbolically. The learning outcomes for the task in figure 4 are counting and writing number 1. I coded the task in figure 4 under AMC because it is about counting objects and writing their corresponding number which is 1 using free hand. This shows that the task provides learners with opportunities for further understanding of the number concept through making connections between quantities of objects, the number concept as well as writing its symbol.

I found that the tasks under units 1 and 4 would provide learners with mathematical opportunities to make their own judgments in terms of the meaning of a specific number concept and in representing quantity using numbers (Ronda & Adler, 2016). This is because the tasks are achievement based, activity based, hence they are learner centred. This implies that these example spaces and tasks can foster OBE to some extent because they are achievement oriented and activity based. I however found that the AMC tasks which mediate learners' capabilities in counting and writing are very few in both units 1 and 4. Although there is demonstration of how numbers from 0 to 9 can be written (for example task in figure 4), the textbook does not provide more opportunities for learners to practice writing the numbers. Furthermore, it is unlikely that the learners can manage to write the numbers without first attempting to trace these numbers on dotted number patterns. As such it would be better if learners were first given an example space where they could trace out the numbers. Provision of more dotted number patterns would also increase learners' capabilities in number concept by fostering learners' active interaction with the numbers through independent practice as demanded by the OBE curriculum (MIE, 2006).

The other limitation is that there are no tasks which provide learners with opportunities to represent number with objects to increase their masterly level of the number concept. For example, there are no tasks which require learners to draw a given quantity of objects to represent a number or to colour objects based on given number. This implies that there is lack of variety in terms of tasks provided to the learners through the textbook. Provision of little opportunities for writing numbers

and representing them might limit learners' understanding of the number concept due to lack of practice, creativity and application.

Conclusion

This paper has presented findings from textbook analysis study which aimed at examining mathematical opportunities available for grade 1 learners to understand number concept through OBE curriculum. The study has found that the textbook has provided learners with different levels of example spaces ranging from low to high level. However, the high level examples which would help learners to engage with various thinking patterns simultaneously are few. In terms of tasks, the study has found that the textbook has provided learners with opportunities to understand number concept mainly through counting objects but not through writing or representations. As a result, the textbook might not foster learners' active involvement and independent learning as required by the OBE curriculum goals. As these findings are only based on textbook analysis, there is need for further studies to focus on how learners engage with this textbook in classroom to find out how these opportunities materialise.

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