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Abstract

Several nations have reformed both their mathematics pedagogy and curriculum. The remaining challenge is to review teaching and learning resources to support the renewed pedagogy and curriculum. This paper responds to the question: What pedagogy and curriculum are depicted in textbooks used in Uganda? Ugandan textbooks were analyzed in terms of *mathematics content structure and genre*, and *presentation of written and non-written voice and looks*. Whereas certain Ugandan mathematics textbooks used the narrative form and others chose to eliminate the use of extensive text, these textbooks include common characteristics such as spiral coverage of mathematics content. A few strides toward *reform pedagogy*, such as use of contexts familiar to learners in development of rules and concepts, were evinced among selected Uganda textbooks. More strides are needed in revising a majority textbooks to align with the renewed curricula on certain aspects including integrating learning tools—digital and non-digital—within the textbook resources. A critical reflection on curriculum renewals adopted from other countries is needed when designing textbooks to match these renewals.

Key words: Curriculum Renewal; School Mathematics; Africa; Uganda; Textbooks; Curriculum Materials; Mathematics Pedagogy; Reform; Former Colonies.

1. Introduction

Internationally, the face of mathematics education is changing rapidly toward the creation of learning opportunities that promise to increase the number of students who enjoy and excel at mathematics. Several nations have reformed both their mathematics pedagogy (how mathematics is taught) and curriculum (what mathematics is taught) in schools. The challenge that remains is to renew the teaching and learning resources that support renewed pedagogy and curriculum. This paper presents findings from a study on the question: What pedagogy and curriculum is depicted in curriculum resources used in schools and to what extent are the curriculum resources and programmatic curriculum aligned? The author takes the case of Uganda which recently renewed its ministry-designed programmatic curriculum and specifically looks at commercially published textbook resources.

Physical curriculum materials such as textbooks and learning tools are still a major resource in teaching mathematics (Gueudet, Pepin and Trouche 2012; Pepin and Gueudet 2014), and have been noted to be a major factor in students' learning (Törnroos 2005). Textbook resources are studied in this paper because they are still a widely-used resource (Gueudet et al.). The use of textbooks as a main resource was observed in many Asian countries (Wu, Park and Leung 2006), in the Pacific Rim and in Continental European countries (Foxman 1999) and in the United States of America (Schmidt, Wang and McKnight, 2005). Of interest to this study, in one of the few studies on Ugandan mathematics education, it is noted that textbooks were often used as a sole resource by Ugandan mathematics teachers (Quinn 1983).

1.1. Background

The current Ugandan school system is organized in three sub-cycles at the elementary school level: Lower primary (Primary 1, P1 to P3), Transitioning Curriculum (P4), Upper primary (P5 to P7) (NCDC 2017). The secondary curriculum is broken into two cycles: Ordinary (O) level (or, lower secondary, Senior, S, 1 to 4) and Advanced level (or, upper secondary, S5 & S6). Two core institutions

of the Ugandan Ministry of Education and Sports (MoES) are centrally responsible for pedagogy and curriculum, and for assessment in schools: The National Curriculum Development Center (NCDC) and the Uganda National Examination Board (UNEB) respectively.

Textbook writing and publication in Uganda are decentralized and handled by commercial publishers. MoES, nonetheless, vets and selects textbooks that it funds in government aided schools. Unreliable centralized textbook distribution and diversity among schools coupled with relatively high costs of textbooks translates into variation of textbook distribution in schools and variation of access to textbooks among learners (Read, Read and Okwenu 2008). The diversity is based on location and socio-economic status of founding bodies and of families served by a school. The percentage of private schools is larger than that of government-funded schools, and the percentage of rural schools is larger than urban schools. Additionally, primary school teachers receive their initial teaching qualification after graduating from lower secondary and as generalists in primary teachers' colleges, whereas secondary school teachers train as specialists at national teachers' colleges and at departments of education in universities. System-wide professional development projects are limited to a few bilateral in-service training projects (such as SESEMAT[i]), and a few opportunities for selected teachers by government bodies. It is vital to study the potential contribution to pedagogy and curricula that textbooks make to the teaching of mathematics in a country where system-wide professional development for mathematics teachers is limited.

1.2 Method and Design

Textbook analyses have been commonly used to understand tacit pedagogy and potentially implemented curriculum (Dowling 1996; Flanders 1994; Herbel-Eisenmann 2007; Mauch and McDermot 2007). To make comparisons with the planned and intended curriculum in policy documents,

[i] The Secondary Science and Mathematics (SESEMAT) was introduced in 2005. It is intended to improve the teaching ability of science and mathematics teachers at the secondary level (Komakech and Osuu 2014).

Remillard (2012) refers to textbooks as the written curriculum, and Tarr, Chavez, Reys and Reys (2006) as the potentially implemented curriculum. Textbooks often influence the nature of content—what is learned and the classroom activities—and influence how, when and in what order the content is learned (Otte 1986). The quality of textbooks has been known to correlate with student achievement on international tests (Törnroos 2005). Fauvel (1991) asserted that, "every textbook author is a teacher at a distance" (p. 114). Although this teacher at a distance is not usually accountable for learners' experiences (Love and Pimm 1996), his/her message greatly influences the learners' experience in a mathematics classroom. Morgan (1996) further notes that the coherent whole and type of *message* in text can be investigated by "considering the *thematic progression*, the *cohesiveness* of a text, particularly the *ways in which reasoning is expressed*, and the *overall structure* of the text" (p. 7).

Li (2000) developed a three-dimensional framework for coding and analyzing tasks in terms of *mathematical features, performance requirements* and *contextual features*. Pepin and Gueudet (2014) illustrate how studies on quality of teaching resources have focused on *mathematical*, *pedagogical*, or *sociological* analyses. To Remillard (2012), curriculum resources have been analyzed along the following dimensions: *structure*, *look*, *voice*, *medium* and *genre*. In the study, Ugandan textbooks were analyzed in terms of *mathematics content structure and genre*, *presentation of written voice and looks*, *presentation of non-written voice and looks*, as well as of *contextual and discourse aspects*. The four dimensions were selected to form the analytical framework for examining the textbooks because they encompass the following major features identified in the literature section: mathematics structure and genre features, written pedagogical presentations, non-written pedagogical presentations and performance requirements, as well as sociological analyses. In a latter section, the author illustrates how the literature contributes to this framework. This paper focuses on the first two dimensions. These dimensions, as we shall see, are by no means exclusive.

1.3 Overarching Perspective for the Inquiry

This analysis of Uganda textbooks is conceptually informed by critical mathematics education theories (e.g., ethno-mathematics and critical mathematics education) and post-modern education theories (e.g., post-colonial and decolonizing education theories). Researchers such as Bishop (1997), Gerdes (1998), Schubring (2017) and Vithal and Volmink (2005) study mathematics curricular, instruction and resources in ways that critique the influence of colonization and of other forms of imperialism. As well, these scholars study efforts that took place among former colonies such as those aimed at making curricular, instruction and resources reflect the cultures and heritages of the countries. Schubring (2017), for instance, observes differences among mathematics textbooks in the post-colonial error of East African countries as compared to other African countries. Schubring noted that selected East African textbooks were still published by British publishers and with illustrations of European heritage. The common tenets of these perspectives are that curricula and schooling are not free of culture, politics or ideologies of their structural, spatial and temporal contexts. Further, culture, politics and ideologies themselves, both in their material and non-material values, are dynamic. What was considered cultural, for instance, when a first edition of the textbook was published may no longer be considered cultural. The analysis of Ugandan textbooks is of relevance to curricula and resource renewals in other sub-Saharan countries and in former British colonies and the commonwealth countries. As Kanu (2003) states, nostalgia for past cultural practices or the lust for post modernity should not solely drive curricula and pedagogical reform discourses. Cultural diversity built up from tribal and indigenous cultures, from contemporary cultures, as well as from more recent emigration and immigration in a country add other layers of complexity (Namukasa, Kaahwa, Quinn, and Ddungu 2011). In addition, for textbook analyses in former colonies it is important to reflect on how much of the locally relevant pedagogies, contexts and curriculum are included in the textbooks in addition to considering the remnants of colonial pedagogy and curriculum.

1.4 Curriculum in Uganda

Modern mathematics reforms that took place in the1960s and 1970s in Britain and in the United States of America informed the previous Uganda mathematics teaching syllabi at primary, secondary and teacher-training levels. Several of the curriculum and textbook writing projects at that time involved multilateral efforts and served numerous African countries. The first editions of the School Mathematics for East Africa (SMEA) and of the Entebbe Math textbooks, it is claimed, for example, were written to adapt the British School Mathematics Project (SMP) and the American School Mathematics Study Group (SMSG) approaches to the education systems of East African and of selected sub-Saharan African countries, respectively (Namukasa et al. 2011). Whereas examination curricula for primary, lower-secondary and upper secondary as well as elementary level teaching syllabi were regularly revised by UNEB and NCDC respectively during the past half century, the lower secondary (O-Level) teaching syllabus was revised only as recently as 2008 and the upper secondary (A-Level) teaching syllabi were written for the first time in 2013 (NCDC 2017). Also, one remnant of the British system is that the examination syllabus continued to guide the teaching syllabus.

The current process of reforming the Uganda curriculum has culminated in a renewed mathematics programmatic curriculum and teaching syllabi written by NCDC for elementary and lower secondary grades. The lower secondary programmatic curricula focuses on mathematics that is required by many learners including those who would not continue to high school and the split of the lower secondary curriculum into a core, functional program, and an extended, academic program (NCDC 2017).

Several differences exist between the previous primary school curriculum (NCDC 1999/2001) and the current primary curriculum (NCDC 2008-2012). As shown in Table 1, each of the Primary 1 to 7 reviewed documents, due to a phased roll-out of the new programmatic curriculum, has a separate policy document with a different year of publication. The Grade 5, 6 and 7, the upper primary curriculum policy documents, have common organization structures and philosophies about curriculum and

teaching. The Grade 7 syllabi, nonetheless, has more in common with the Grade 6 syllabi and has additional structures and further elaborations about the renewed curriculum. In the Grade 7 document it is stated that it is important for a teacher to understand the "philosophy and rationale underlying the intended curriculum," (p.128, NCDC 2012). The Grade 7 scope elaborates several aspects of the curriculum, including: values, suggested methods, and suggested instructional materials, learning outcomes, teacher notes and assessment competencies, life skills, subject competencies, language (equivalence of communication) competencies, content and suggested activities. Several philosophies and rationales are highlighted, including: Integration; experience-based approaches; problem solving; formation of important concepts; the role of the teacher as a guide; and a focus on appreciation of mathematics as well as on confidence and creativity. The previous primary school curriculum (NCDC 1999/2001) outlined a briefer rationale and focused on a few of the philosophies outlined in NCDC (2012). Similarities among the revised and previous teaching syllabi include emphasis on integration and logical thought, the spiral arrangement of topics, and mention of only a few process standards such as problem solving and conducting investigations (NCDC 1999/2001). Not much is said in the renewed curriculum about some of the controversial conceptions in mathematics education such as the conception of subject competencies.

Major difference between NCDC (2008) —the current lower secondary teaching syllabus – and NCDC (1990/1992) — the lower secondary teaching syllabus— were on the scope and sequence of topics. The revisions included: changes in sequencing of topics; reduction in total number of topics by 16 topics mainly due to consolidation of sub-topics into major topics; and renaming of some topics with more general designations. On the other hand, other changes involved the further splitting of certain topics, such as geometry and measurement, into sub-topics; and renaming certain topics with more specific topic designations. NCDC (2008) listed 21 topics for Senior 1, 17 topics for Senior 2, 16 topics for Senior 3, and 10 topics for Senior 4; that is 16 fewer topics than NCDC (1990/1992). Although quantitative in nature, these differences in the scope signal revisions in the thematic progression

(Morgan 1996 and Otte 1986) of the curriculum. Further, NCDC (2008) elaborated on the comments section, which was originally in NCDC (1990/1992), in terms of teaching and learning strategies for every topic. NCDC (2008) included information on mode of assessment while this information was not included in NCDC (1990/1992). Except for a few aspects, NCDC (2008) is more in line with the previous primary school curriculum (NCDC 1999/2001) than the current one (NCDC 2008-2012). Integration of mathematics with other subjects, for example, is mentioned in both the previous primary (NCDC 1990/1992) and the current (NCDC 2008) lower secondary teaching syllabus.

The proposed new lower secondary curriculum (NCDC 2017) is further organized in 5 content strands (number, shape and space, data and probability, patterns and algebra, and measurement) as is the case of the revised primary curriculum (NCDC 2008-2012) where syllabus topics are clustered among 6 themes and by 1 process strand. Problem solving and communication (i.e., linguistic/communication-related competencies) are key processes in NCDC (2008-2012) syllabi. Similarly, details on outcomes and suggested activities are listed for every topic much like in NCDC (2008-2012). Additionally, evidence of achievement and exemplar assessment activities are listed for every topic/sub-strand in NCDC (2017). Alongside each of the topics in the teaching syllabi, in a manner similar to NCDC (2008-2012), NCDC (2017) specifies generic life skills (e.g., creative skills), values (e.g., positive attitude towards work), and competencies (e.g., subject-specific competencies). NCDC (2017) coheres with NCDC (2008-2012). Both have aspects related to recent curriculum reforms, such as organizing curricula by content strands, including process standards, and a focus on classroom assessment as is the case in several other nations (e.g., NCTM 2000).

Certain aspects of teaching mathematics such as equity and selection of appropriate physical and mental learning materials, tools and technologies are still not emphasized at both elementary and lower secondary level. Brief statements are included in the curriculum without much elaboration. The changes in NCDC (2017) and NCDC (2012) are new for a former British colony which, until recently, had not renewed its teaching curriculum. In the policy documents successes and challenges of the changes

adapted from other countries are not mentioned. These, however, would be important to reflect on when designing resources that support the renewed curriculum. With the renewed curriculum, there is a need to study aspects of the ways in which the major curriculum material, textbooks, might support or not support the renewed mathematics curricula.

Table 1. *Ugandan Mathematics Curriculum Documents.*

Primary Syllabi		**Lower secondary Syllabi**			**Upper Secondary**
Revised	Reviewed	Old	Reviewed	Renewed	New
NCDC 1999/2001	NCDC 2008-2012: Primary 3 (NCDC 2008) Primary 4 (NCDC 2009) Primary 5 (NCDC 2009) Primary 6 (NCDC 2010) Primary 7 (NCDC 2012)	NCDC 1990/1992	NCDC 2008	NCDC 2017	NCDC 2013.

Table 2. *School Mathematics Textbooks Analyzed*

O-Level, Lower Secondary, Textbooks
Malimu (2004, 2005): Patel, N.M., and Patel, G.A. Mathematics for Kenya Schools, Book 3 (2004) & Book 4 (2005). Nairobi, Kenya: Malimu.
Cambridge (1969/2000a, 1971/2000b, 1977/2000c, 1960/2000c, 1960/2000d): Kaahwa, J., and Quinn, M. School Mathematics of East Africa, Book 1 (1969/2000a), Book 2 (1971/2000b), Book 3 (1977/2000c), Book 4 (1960/2000d) the revised edition. Pearson-Longman , UK: Cambridge.
Pearson-Longman (2007): Macrae, M., Segujja-Munagisa, E., and Gonzaga, M. New General Mathematics, NGM Book 3. Essex, England: Pearson-Longman.
G. Bell (1949/1955, 1970/1984): Parr, H.E. School Mathematics, SM Books I for Senior 1 & 2 & Book II for Senior 3 & 4. London, UK: G. Bell.
MK (2009): Kyamuanwire G. et al. MK Secondary Mathematics, Book 3 (2009 edition). Kampala, Uganda: MK.
MK (2008): Kironde M., Namukasa, I., Mango, M.J., and Kasirye, S. MK Secondary Mathematics, Book 3. Kampala, Uganda: MK.
Moran (1998/2011): Karuhije E., Opolot-Okurut, C., Kawooya, M., and Opyene, P. Secondary School Mathematic, Book 3. Kampala, Uganda: Moran.
Oxford (2004). Owondo V., Kang'ethe, S., and Mbiruru, W. (2004). Discovering Secondary Mathematics, Book 3. Nairobi, Kenya: Oxford.
Longhorn (2010): Mugo, K., Maina, L., and Ondera, J. Advancing in Mathematics, Book 3. Nairobi, Kenya: Kampala, Uganda; Dar es Salam, Tanzania: Longhorn.
Elementary, Primary Level, Textbooks
MK. (1998/2006, 2008): Kyambadde, D. Wabwire C., Nakitto F., and Serwanga, S. Primary Mathematics, Book 4 (1998/2006), Book 7 (2008). Kampala, Uganda: MK.

1.5 Textbooks in Uganda

The lower secondary mathematics teaching syllabi, NCDC (2008), continued the practice of mapping curriculum topics alongside specific textbook units from nine textbooks. The primary teaching syllabus, NCDC 2008-2012, referred to textbooks previously used, yet NCDC (1999/2001), the previous primary curriculum, did not refer to textbooks used. Read et al. (2008) maintained that the large number of specified textbooks for lower secondary in Uganda was a result of curriculum design and lack of ministry-approved lists of textbooks. Beginning from Grade 4, English is the language of instruction, curriculum is subject-based (as opposed to a thematic-based) and textbook materials are recommended for use (NCDC 2017). Many primary school and lower secondary mathematics textbooks were published in the country. What follows is an analysis of selected textbooks used in the upper primary and lower secondary, Primary 4 to Senior 4. Table 2 shows the details of the textbooks conveniently selected from a dominant textbook seller (Read et al.) in one urban area, from one suburban bookstore and one suburban school. Sixteen textbooks were analyzed: 1 Grade 4; 1 Grade 7; 1 Senior, S, 1; 1 S2; 1 S1 & 2; 1 S 3 & 4; 8 S3; and 2 S4 textbooks. The author did not focus on textbooks for grades lower than Grade 4 because non-textbook materials are recommended for use, and schools in non-metropolitan regions use tribal languages as the language of instruction (NCDC 2017). The author did not focus on textbooks for upper secondary because, except for teacher-made booklets, a majority of upper secondary textbooks were published outside of East Africa, and the post-colonial upper secondary teaching syllabus was only recently written in 2013. Purposeful sampling of the lower secondary textbooks was not feasible due to lack of centralized textbook approval. Read et al. (2008) observe that lack of a centralized system for approving, recommending and pricing of textbooks has resulted in a greater variation of lower secondary textbooks used in Uganda. That the sample for the study included varied publishers and authors is in line with the practice in the policy documents and schools to recommend more than one textbook. Moreover, that the sample from two book stores and a school included three

books published in England, two books published by British publishers and a book published during the colonial era is a reflection of the textbooks available for use in schools, given the following factors that prevailed during the post-colonial period: inadequate practices of textbook distribution and approval (Read et al.); a curriculum that for decades largely remained true to its British origin; the influence of multilateral funders such as the World Bank who funded textbooks by Western publishers (Schubring, 2017), and the limited system-wide support and renewal of curriculum development and renewal of teaching resources.

2. Background Review

The review that follows is categorized under two dimensions. These dimensions provided the analytical framework for studying the curriculum and pedagogy in Ugandan mathematics textbooks.

2.1 Content Structure and Genre: Organization, Methods and Scope

Content organization, methods of presentation and Scope of coverage are major aspects identified in the literature on the content in the textbooks. The organization, presentation and subject matter (Remillard 2012) are all significant to the pedagogy in a textbook (Ernest 1999; Meyer, Greer and Crummey 1988; Mayer, Sims and Tajka 1995). Mayer et al. recommend *content presentation that emphasizes multiple* representation of content as well as multiple solutions. They suggest that textbooks should *present a few basic topics in depth, organized in coherent lessons*. Similarly, Johnson and Smith (1987) encourage content organization *by lessons rather than chapters*. On the contrary, certain researchers argue that organization of content by lesson *represents content as discrete pieces* and so do not *facilitate a holistic pedagogy* (Remillard). Schoenfeld (1992) posits that the structure in most mathematics textbooks *carves subject matter into separate pieces, providing each bit with explicit instruction*. Reys, Reys and Koyama (1996) observed that Japanese grades 1-3 textbooks were segmented into about twenty chapters with *each chapter focusing on a single concept or topic* spanning

one or more lessons. *Organizing curriculum units by broader themes and strands* rather than by narrower topics has been known to assist with concept building (Mauch and McDermott 2007). Such content organization in textbooks avoids cursory and repetitive teaching of topics (Quinn 1983), which delays students' mastery of topics (Kang 2014). Schmidt et al. (2005) suggest *avoiding the inclusion of every topic at almost every grade level*.

In addition to content presentation, Meyer et al. (1988) maintain that content should be *presented in a discussion method* rather than a *lecture tone* to facilitate *interactive pedagogy*. In Woodward (1986) textbooks that use the former tone were labeled *dialogic* and the latter *univocal* textbooks. *Dialogic* textbooks are *active links*, for they offer *possibilities for students to actively participate in the generation of meaning*. *Authoritative* as opposed to *interactive communication* characterizes the common pedagogy in mathematics textbooks (Dowling 1996). Also, *generalized strategies* as opposed to *localized strategies*, *didactic* as opposed to *conversational and narrative forms* of teaching, and *exposition* as opposed to *inquiry methods* are common structures in mathematics textbooks. Mauch and McDermott (2007) identified an American textbook, Math by Scott Foreman-Addison Wesley, to have the *explanation-example-practice* genre and labeled it a *traditional mathematics* textbook. Foxman's (1999) analysis revealed the same about Hong Kong textbooks. Most studies indicate that the common structure of mathematics textbooks *legitimizes drill and practice*, a sole emphasis on *content at the neglect of mathematics processes and practices*, and the *rhetoric of conclusions* that is typical of traditional mathematics curricula (Cooney, Gofree, Stevens, and Nickson 1985).

Flanders (1994) refers to the broad scope and relative emphasis on number and numeration, and number patterning and algebra evidenced in American textbooks as the *arithmetization* of curriculum. Flanders maintains that, given *their wide scope and coverage along* with *early sequencing* in the first half of the textbook of number concepts, Grade 8 American textbooks reflect the view that arithmetic is most important. This bias towards arithmetic occurs in Canada, Scotland, and Switzerland; but differs in other countries, such as Japan, Singapore, Czech Republic and Hungary, which have *more geometry*

coverage (Foxman 1999). The literature reviewed on content structure and genre formed the first dimension of the analytic framework for this paper.

2.2 Pedagogical Presentations: Written Language and Voice

Another major theme on the literature on pedagogy depicted in mathematics textbooks focuses on of style and structure of the language of communication as well as the structure of mathematics written symbols. Varied communication styles are used in textbooks (Remillard 2012). Morgan (1996) and Herbel-Eisenman (2007) observe that most mathematical textbooks *use imperatives* as *prompts, questions, explanations,* and *exercises,* rather than *modal verbs and their nominal forms, or even children's colloquial language.* For example, "calculate ¼ + ½" is a common format in textbook tasks. Dowling (1996) and Herbel-Eisenmann mention that the *authoritative structure* embedded in the use of imperatives is the *top-down teaching style* where *students' participation is more on the side of receiving than on the side of constructing knowledge*. Morgan (1996) also illustrates *how nominalization (forming a noun from a verb) allows an abstract level of manipulating ideas but obscures human agency* in the mathematical activity. The use of the *top-down teaching style* infers *a prescriptive approach that occasions learners to become passive* (Ernest 1999). The dominant use of *non-human actors*, *use of passive verbs*, sole use of *technical, standard mathematics notation* (as opposed to the inclusion of *dialogue, narrative and illustrative forms*), and the avoidance of *spatio-temporal locators* further obscure teacher and learner agency (Ernest 1999; Morgan 1996; Tarnau 1980).

In addition to analyzing *textual style* and *grammatical structure* of the language used in a textbook, researchers have also analyzed the nature of written *verbal-mathematical language*. van Dormolen (1986) classifies mathematical language into *demonstrative* and *relative* language, where the former deals with *examples* and the latter with *general rules*. He also distinguishes between *descriptive level* and *procedural level language*. Dowling (1996) notes that the *procedural language* presents the text as *context-independent* and ignores the *student's voice* while stressing *the voice of mathematicians*

or *of the author*. Furthermore, Tarnau (1980) argues for *a formulation of rules in context* and avoidance of *showing rules in isolation*. Schoenfeld (1992) remarks that *the presence of rules that are simply stated in their already generalized form* immediately followed by examples and then *a practice and drill exercise* legitimizes the *transmission form of teaching*. When a *sequence of routine problems to be solved with the help of the same rule* is given, students are likely to miss out on the nature of mathematics encountered through the process of solving non-routine problems (Schoenfeld). In Japanese, as is the case of Singaporean textbooks, *lessons were planned around fewer key problems* (Foxman 1999). Reys et al. (2006) observe that Japanese texts had *fewer practice exercises* than textbooks published in USA. Kang (2014) observed far fewer story problems in a USA traditional textbook (Harcourt) than in the Korean textbook. Kang also observed far fewer story problems in a USA standards-based textbook (Investigation) at both Grade 1 and Grade 4.

The literature reviewed on *textual style, grammatical structure* and the nature of *verbal-mathematical* formed the second dimension of the analytic framework for this paper. Literature on other dimensions such as on *presentation of non-written voice and looks including visual representation,* as well as of *contextual and discourse aspects including real-life contexts* is beyond the scope of this paper.

Given the varied dimensions — including structure, presentations (written and other) and contexts of textbooks — it is common for textbooks to carry inconsistent messages about the curriculum and pedagogy in a country. Love and Pimm (1996) noted that even those textbooks that were taking strides away from the traditional pedagogy toward reformed curricula usually managed to do so only at a surface level.

3. Results: Features of Ugandan Mathematics Textbooks

In the sections that follow the author shares findings on the *content structure and genre, and pedagogical presentations of written language* of Uganda school mathematics textbooks. Due to limitations of space, results on the *pedagogical presentations of other materials* as well as on the

contextual and discourse dimensions are not included here. Also, Namukasa, Quinn and Kaahwa (2010) discussed the physical appearance of Ugandan textbooks.

3.1 ***Content Organization and Genre: Organization, Methods and Scope***

A close similarity among a majority textbooks was that the units were grouped by topic rather than by broader strands in all textbooks. For instance, data display, mean and media were 3 separate topics in the S3 books. Whereas Moran (2011), Pearson-Longman (2007) and MK (2009), textbooks for Senior 3, were still organized by topic for several units, they included a unit on numerical concepts that combined two or more number and numeration topics. And, whereas Pearson-Longman (2007) was organized by topic for several units and included a chapter on numerical concepts, it additionally started off the textbook with a preliminary unit organized by strand instead of by topic that reviewed work covered in the previous two years. Further, the topics sequence was mostly similar in the Senior 3 textbooks. For example, the trigonometry chapter appeared in all 8 textbooks and was placed in the first quarter of the textbooks, apart from one textbook G. Bell (1984) Book 2 for Senior 3 and 4, where it instead appeared in the second quarter. G. Bell (1955) Book 1 for Senior 1 and 2 included a unique unit on problems that appeared to be about the practice of using algebra to solve word problems. Only a few textbooks included introductory or preface pages where the structure or the pedagogy of the textbook was explained. G. Bell (1955) explained, "Most teachers are of the opinion that it is unwise to keep a class on the same topic for more than a week or so .... [I]t will be found that subjects are broken into by other topics" (G. Bell 1955, p. v.). The organization of content by topic rather than by strand meant that the analyzed textbooks consisted of several units.

Coverage of topics from different strands varied and was not biased toward numeration-number and algebra topics. In one elementary level textbook, MK (2006) for Primary 4, 9 of 22 units were concerned with numeration-number and algebra topics, and 10 of the 22 units were geometry and measurement topics. Cambridge (2000a), Cambridge (2000b), Owondo, Kang'ethe and Mbiruru (2004),

Malimu (2004), all for Senior 3, had slightly more numeration-number and algebra topics. Cambridge (2000c) and MK (2008), for Senior 3, had equal geometry and measurement topics as numeration-number and algebra topics. Moran (2011), Pearson-Longman (2007), MK (2009), Malimu (2005), G. Bell (1955), G. Bell (1984) covered more geometry and measurement topics. Additionally, textbooks for some consecutive grades repeated content at the two grade levels. For instance, units on matrices and trigonometric ratios were in both the S3 and S4 textbooks.

Content was presented in the following order: introduction to the chapter/unit; introduction to the subtopic, procedure or concept; teaching of a specific subtopic; corresponding worked-out examples/activities; exercises; and then a conclusion of the unit. The focus of the beginning, the middle and the end of the units varied with publishers, editions, grades and units. Mugo, Maina and Ondera (2010) and Moran (2011) included a review of relevant procedures and concepts at the beginning of the units. Pearson-Longman (2007) started off the textbook with a preliminary unit that reviewed work covered in the previous two years. MK (2009) included both learning objectives and importance of the topic, whereas MK (2008) included only the former. Pearson-Longman started off with the objectives of the unit. MK (2009) and Cambridge (2000c) included sentences on the history of mathematics in the introductory sections.

The introductory section was immediately followed by introduction to, development of, or an explanation of a specific subtopic. In most cases explanations were then followed by single or multi-part examples together with their worked-out solutions and explanations. In some rare cases, an alternative method, another method, or a shorter or simplified worked-out solution was additionally offered. For selected topics such as solving equations both the algebraic and graphical methods were taught in the same unit and MK (2009) covered up to 5 methods (2 algebraic, 1 graphical and 2 by use of matrices) in a unit. Longhorn (2010) used the words “alternatively” or “an alternative way” when offering alternative solutions for selected worked-out examples. Text boxes or bubbles with hints to a solution or notes were often placed adjacent to the solutions. The worked-out examples were subsequently followed by

exercises for practicing the learned rule, procedure or concept; and then subtopics were introduced. MK (2008) included definitions in note boxes within a section. The Senior 3 books, Longhorn (2010), Oxford (2004), Malimu (2004), Moran (2011), G. Bell (1955, 1984), Pearson-Longman (2007) highlighted in bold mathematics terminology in the sections; Cambridge (2000) used italics; MK and MK (2008) used another color. MK (2006), on the other hand, included a glossary of definitions at the end of the book. Pearson-Longman and Cambridge (2000c) also included an index.

In the middle of the sections, certain textbooks included generalizations and rules in the form of observations from structured examples, activities or projects instead of as already generalized rules stated at the beginning of a section. Other textbooks outlined the rules in their already generalized form. Other textbooks did a combination of both approaches. For example, Longhorn (2010), G. Bell (1984) and Cambridge (2000c) introduced the Tangent, Sine and Cosine ratios, in the trigonometry unit, through a measuring activity of the opposite, adjacent and hypotenuse sides of similar triangles, and then used a tabular organizer to guide students to calculate and record ratios among the sides. Students were then prompted to make observations about the constant ratios. Activities in these textbooks prompted students to notice a rule or concept as a generalization. The authors then introduced the definitions and procedures for calculating each of the ratios. G. Bell (1984) and Cambridge (2000d) then summarized the rules and generalizations as a chapter summary. Longhorn summarized the rules within the section. Moran (2011), on the other hand, first offered the definition and procedure of a trigonometry ratio and followed this with an explanation and examples. Oxford (2004) and Malimu (2004) offered all 3 definitions at once and used a different approach to the ratios using the unit circle. In Malimu it is indicated that this was the second trigonometry chapter in its series. A similar triangles approach had been used in their book for Senior 2. MK (2009) and MK (2008) followed each definition with a measurement activity. Pearson-Longman (2007) used the measurement scenario in their elaboration on the definition. At times, instructions in the form of think, take note, hence/thus, notice, note, observations, in general, recall or remember prompts and bubbles were added to the explanations or

between subsections in a manner that made the definitions, rules and procedures appear like suggestions or hints for the students to consider. Tasks set in the context of investigations, activities and projects appeared more frequently in Cambridge (2000a-c) Grade 1-3 and Longhorn and to a limited extent in MK (2009) and MK (2008). Certain textbooks, such as Longhorn and Pearson-Longman , included boxes with related general education information, such as on health.

Commonalities and differences were also observed in the conclusion of the units: Moran (2011), Pearson-Longman (2007), MK (2009) and Cambridge (2000) for Senior 4 included a summary of unit's topic at the end of the unit. The last section in Longhorn (2010) for topics that appeared abstract (e.g., trigonometry ratios, vectors and simultaneous equations) was on application of the topic. This section on application followed a similar structure as the other sections: an introduction, explanation, examples, and exercises. Pearson-Longman included puzzles at the end of several units. Cambridge (2000c) included puzzle corners with non-routine tasks, such as the consecutive number sums problem and the Mobius strip activity at the end of the book. Except for Malimu (2004), Malimu (2005) and Longhorn, textbooks added culminating or revision exercises. At the end of their textbooks, G. Bell (1984), Oxford (2004), Pearson-Longman (2007), Moran (2011), MK (2009) and MK (2008) included formula, symbols and logarithmic tables. Cumulative and review exercises in Longhorn were included after every 5 chapters or more. G. Bell (1955), G. Bell (1984), MK (2006), MK (2008), Cambridge (2000d), and Longhorn appended revision or test questions to the textbook. Pearson-Longman , Moran, MK (2006) and MK (2008) included answers to exercises in the textbook. Cambridge (2000a-d) included answers in the teacher's book; whereas Moran, and Malimu (2004) included no answers.

Shifts in structure also occurred between publishers, editions, grades, units and sections of the exercises: the Cambridge (2000b), the revised edition, amalgamated a whole unit on integrating modern technology. Longhorn (2010), Cambridge (2000c), Moran (2011) showed how to use mathematics calculation tables to evaluate the trigonometry ratios within the trigonometry unit; whereas MK (2009) and MK (2008), Oxford (2004) and Malimu (2004) Senior 3 showed both the use of the trigonometry

tables and the use of a calculator. Oxford (2004), and Malimu (2004) showed the use of calculators for the unit on approximations and errors. Unlike MK (2006) for P4, the MK (2008), the book for the last year of primary school, P7, was devoid of stories and contexts. Moran explained why they did not include extensive narratives: "unnecessary words and introductions have been avoided. In the classroom, most students prefer doing mathematics instead of reading lengthy explanations in textbooks. We expect the best from all the students" (p. vi). Prompts for discussion and a task that involved an examination of a procedural error were offered in MK (2008): "A boy divided 188 into two halves and gave the answer as 100. Why do you think he thought he was correct?" (p. 7). The probability and statistics unit included more narratives, word problems and real-world contexts than standard mathematical symbols, images, and illustrations. Most of the culminating exercises included word problems or problem with real-life stories in their later half.

3.2 Pedagogical Presentations: Written Language and Voice

Representations were diverse, ranging mainly from *verbal-written, through symbolic and graphical representations* to *drawn and photographic illustrations* of mathematical concepts and procedures as well as representations of concepts and procedures drawn from outside school mathematics. The *verbal-written* and *mathematical symbols and graphical representations,* nonetheless, were more dominant in several books and units. Among the *verbal-written, imperatives,* as well as *pronouns*, such as "we" and "you," were commonly used. In Malimu (2004), Moran (2011), Pearson-Longman (2007) and Longhorn (2010), the authors referred to the student as "you" and in Oxford (2004), MK (2009), and G. Bell (1984) as "we." When listing the learning objectives for the units, MK also appeared to address the teacher (or, parent) as they talked about "the learner." Several textbooks, such as Moran, which limited the use of narratives and word problems, evinced the dominant use of *technical, standard mathematics notation,* and *avoidance of spatio-temporal locators*. Also, *relative and procedural-level language* was common where lessons were organized around rules and procedures in

their *already generalized form* stated at the beginning of the sections. As well, the *voice of mathematicians* and *of the author* was more stressed in these textbooks.

Narratives and stories, as well as non-standard school mathematics illustration, such as photographs, were more common in books that developed the rules or definitions through contexts and presentations. As stated earlier, Moran (2011), explained the avoidance of dialogic and narrative form as equity efforts towards being inclusive to learners with lower reading levels are averse to "reading lengthy explanations in textbooks" (p. vi). The *discussion tone* was limited to textbooks with discussion prompts, projects and activities. Cases of stressing the *student's voice* as opposed to *the voice of mathematicians* and *of the author* were observed in textbooks where students were asked to make observations through activities, projects, and puzzles. Cambridge (2000c) also planned some lessons around group work. Further, *descriptive and demonstrative language* was evinced in the activities, projects, and application opportunities, as well as in all textbooks as they included mathematics application and word problems set in a real-life or a narrative context. The boxes and bubbles, as pseudo dialogue prompts, at times asked the student to engage in the process of reflection and reasoning; but in most cases the boxes told the student what to reflect on and what to remember. Dialogue among learners, teachers or other people about the content of the section was not observed in the textbooks.

4. Discussion

Ugandan school textbooks appeared to share characteristics with textbooks of several other countries, especially former colonies that have been slow to represent socio-cultural and political awareness in their revised or new textbooks. Ugandan school textbooks characteristics, similarly, reflected the potentially implemented pedagogy and curriculum (Tarr et al. 2006). Whereas the organization and presentations among the textbooks had certain commonalities, such as organization mostly by topics rather than strands, the following major differences existed among the textbooks: most text books offered rules in their already generalized forms; a few textbooks used the narrative tone; and

most textbooks used several standard mathematical images and illustrations. Some features, such as the numerous units and absence of narratives, were justified by the authors (G. Bell 1955; Moran 2011). Other features, such as the inclusion of sections on mathematics puzzles and on applications, were not explained by the authors, but perhaps related to earlier British SMP and American SMSG reforms. The following characteristics were peculiar to one or two textbooks: use of project work, puzzles comprising of non-routine problems, sections on the use of calculators, inclusion of reasons for studying a topic, and a section on applications. The dimensions studied were not exclusive. Textbooks that used the narrative tone in in the application questions, for example, also offered more real-life contexts and representation as well as activities through which to guide the students to notice the rules and procedures. On the other hand, where a narrative tone was avoided, a more generalized and decontextualized tone was evinced.

4.1 ***Content Organization and Genre: Organization, Methods and Scope***

Ugandan textbooks aligned with Johnson and Smith (1987) preference of content presentation by lessons or topics. The wide and cursory coverage as well as the *spiral design* in which some content at consecutive grades was repeated reflect much of the previous teaching syllabi (e.g., NCDC, 1990/1992; 1999/2001) and the current teaching syllabi (e.g., NCDC, 2008) in which 16 topics per grade on average were listed and it is mentioned that the spiral arrangement of topics is used. The organization by topic, nonetheless, does not facilitate a holistic pedagogy (Remillard 1991) and may not assist with concept building (Mauch & McDermot 2007). This organization of content by topics is not aligned with the organization of content by strands as seen in the renewed curriculum (NCDC 2017). Ugandan textbooks, nonetheless, showed a more balanced scope among number and numeration, patterns and algebra as well geometry and spatial sense (Flanders 1994; Foxman 1999; NCTM 2000).

The most common textbook progression was: background, content explanation, a few examples followed by exercises then followed by review exercises. The mathematics genre of explanation-example-practice was observed among American (Foxman 1999) and Hong Kong textbooks, which

Mauch and McDermott (2007) labelled *traditional mathematics*. Cooney et al. (1985) agree that the structure of some Ugandan mathematics textbooks that follow the order of stating already given rules and procedures-examples-exercises *legitimizes drill and practice, content emphasis, and the rhetoric of conclusions*. Textbooks that comprise several worked-out examples, exercises, culminating exercises and their answers as well as test papers, on the other hand, might not be *teacher-proofed* but instead offer *more explicit instruction* and *frequent feedback*.

Through activities and project work, the few textbooks which delayed stating the rules appeared to present the content in an *interactive mode* (Meyer et al. 1986). Instead, certain textbooks, included the activities that could have been used to deduce the rules as follow-up activities to *the rules already stated.* Love and Pimm (1996) interpreted the differences among textbooks and shifts among units, not as inconsistent messages, but as evidence of strides toward *reform pedagogy*. *Interactive and conversational* pedagogy (Dowling 1996) was evinced in textbooks that: applied a narrative tone, included pseudo dialogue bubbles and boxes, or utilized activities and project work, as well as those textbooks in which generalizations were offered as observations through student activities and projects. The puzzles and projects sections were the only sources of non-routine problems for supporting *lessons around fewer key problems* (Foxman 1999). The incorporation of group work, activities and projects, in a manner aligned the current teaching syllabi (NCDC 2008; 2008-2012, 2017), appeared to support the inclusion of other teaching methods in addition to the lecture mode.

4.2 Pedagogical Presentations: Written Language and Voice

The dominance of the *standard mathematics notation symbols and graphical representations* was more prominent among specific textbooks that did not use the narrative form, among selected units and parts of exercise which were treated in a standard symbolic manner. That *imperatives, use of pronouns* were more common and that *narratives* and *stories* and *real-life contexts* were rarely used in these textbooks demonstrates an *authoritative structure* (Morgan 1996). Also, *relative and procedural level language*

was common where lessons were organized around already generalized rules and procedures *(*van Dormolen, 1986). It appears the modal learner for one of the textbooks, Moran (2011), which offered a rationale for avoiding the use of lengthy narratives, was a learner who was also learning the language of instruction. This modal reader is probable given the linguistic and economic diversity that exists among Ugandan schools in both rural and urban settings, and given the diversity among students. That all textbooks included real-life narratives and word problems in exercises provided, to some extent, for inclusion of *narrative forms* and use *of spatio-temporal locators* (Ernest 1999; Morgan 1996) in even those textbooks that avoided use of narratives in the first and middle parts of their units. The textbooks that included activities, non-routine problems, pseudo dialogue and projects, nonetheless, had the potential to promote *demonstrative language* as well as teacher and learner *voice and agency* (Dowling 1996). In addition to the pseudo dialogue boxes, more could be done in the textbooks in terms of adopting an approach for *non-linear interactive pedagogy* (Otte 1983) that includes dialogue of human actors. Dialogue among human actors might align itself more closely to the ways of teaching in traditional Ugandan tribal cultures. As well, to align with the renewed curriculum (NCDC 2012; 2017) opportunities for development of ideas could be expanded from direct instruction, guided examples and activities to using manipulatives, discussion and problem solving, and using digital technologies. Moreover, textbooks at the lower secondary school need to be revised to cater to the two different streams of mathematics students, in ways that maintain high expectations for all students. As well, sociological analyses of textbooks are needed to shed light on the ways in which specific real-life narratives and word problems are relevant to students in the post-colonial era.

5. Conclusion: Identifying Curriculum Renewal Support Priorities

Whereas certain textbooks applied the narrative form and others chose to eliminate extensive narratives, shared characteristics among current Ugandan school mathematics textbooks include: wide, cursory and spiral coverage on mathematics content; learning activities organized around specific topics

than strands; extensive use of detailed standard mathematical illustrations; a landscape of practising; as well as limited integration of ancillary materials and of contexts outside of school mathematics. As seen in the previous section, several of these characteristics, such as a spiral design and a focus on logical thinking, were in line with the previous, adoptions of British and American curricula, and current ministry curriculum documents. Some features, however, such as the inclusion of test papers in textbooks, appeared not to be supported by previous, present, and the proposed curriculum, but possibly were due to the influence of the examination board's syllabi on which, following the British system, the old primary and secondary syllabi were based.

Strides toward *reform pedagogy* that were evinced among the Uganda textbooks are along the areas of use of contexts familiar to learners in development of rules and concepts; utilization of varied teaching methods, including project work and non-routine problem solving; using the narrative tone; including non-standard mathematical images and illustrations such as those from real life and advanced mathematics, inclusion of a variety of tasks, such as mathematics puzzles, applications contexts, use of physical and digital technologies, as well as adding explicit statements on the goals, outcomes or expectation of studying a topic. Although these strides are isolated in specific textbooks, they appear to be in line with the proposed renewed curriculum in which, for instance, several teaching and learning strategies are outlined.

The scope of the study reported in this paper was limited to analyzing textbooks using convenience sampling. Further research is needed to study a much larger sample of textbooks as well as accompanying teacher manuals and textbooks for the advanced level. Empirical studies of the examination system, the teacher education system, and of other mathematics teaching and learning resources as well as field work in schools would reveal how the characteristics of textbooks shared here influence implemented curricula and practised pedagogy. Further, because little cultural awareness is represented in the curriculum, there is need to research the extent to which textbooks published in the country or in the East African region are adopted to the diverse Uganda cultures, religions and heritage.

The results shared in this paper show that more strides are needed in revising a majority textbook resources to align them with the renewed curricula. The changes in the proposed renewed Uganda school curricula appear to draw from or relate to several reforms that have taken other nations decades to converge on. Long strides, for instance, need to be made to integrate learning tools—digital and non-digital—with the use of textbooks. The onus should not be left to the teachers or the teacher trainers to bridge gaps between renewed curriculum documents and available curriculum materials. Teacher Coordinating Centres could focus on providing continued professional development on pedagogies and on designing and sharing teacher-made resources. Resources that are compatible with more affordable hand-held technologies such as smart phones, materials accessible on low-band width Internet, physical and visual resources used in other learning areas could be integrated to support the teaching of mathematics.

The renewals needed in teaching resources ought to continue putting into consideration the needs, values, material resources and contexts of the Ugandan learners, teachers and society. Further, reforms in curriculum resources need to be made in consideration of the new aspects in the renewed curriculum, such as, what in the curriculum are referred to as, values towards mathematics and process competencies (NCDC 2008-2012; 2017). As well, critical reflection is needed when writing textbooks to match renewals, such as the renewal to focus on functional mathematics for some students as opposed to the same mathematics for all students because distinct mathematics for specific students might be colonizing (Vithal, and Volmnik, 2005).

Researchers and policy makers need to continue to grapple with the broader question of re-imagining a relevant, accessible, and interesting mathematics curriculum for a post-colonial country. A de-colonized mathematics education, which also uses locally relevant pedagogies, contexts and curriculum, would require that more Ugandan textbooks are authored and published in the country and for the Ugandan curriculum.

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