Chapter 2
Towards a Harmonized Curriculum in East Africa: A Comparative Perspective of the Intended Secondary School Mathematics Curriculum in Kenya, Rwanda, Tanzania and Uganda

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Abstract This chapter presents the results and insights gained from a comparative analysis of the national secondary school mathematics syllabuses of Kenya, Rwanda, Tanzania and Uganda. Whilst considerable commonalities were found, it was particularly Rwanda, with a different colonial past, which was found to have a more formal curriculum, exemplified in the lack of mention of measurement below the fourth year of primary school and the absence of approximation as a topic. Differences in sequencing topics were found, e.g. Uganda and Rwanda introduce number sequences in year 4 as a means of contextualizing algebra, Tanzania and Kenya introduce them in year 10 somewhat more formally. The continuance of calculations in shillings and cents in Tanzania and Kenya, and the use of logarithms as a calculation tool in Tanzania, Uganda and Kenya can be taken as evidence of a mismatch between what happens in school and the outside world. Differences are acknowledged between the stated curriculum on the one hand, and what gets taught by teachers and indeed learnt by children on the other. Whilst considerable work has been undertaken already to update the curricula in different ways, further work is required to ensure that the syllabus across the region is fit for purpose for the 21st century, not least in engaging all learners in this important subject.

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Introduction

Mathematics education in the East African region, just like in many parts of the world, faces many challenges and opportunities associated with population growth, technological advancement, regional interdependence, and globalization. In response to these challenges and opportunities, several curricular reforms in mathematics education have been proposed and implemented in the region since independence. The latest of these endeavours is the proposal to have a harmonized curriculum across the partner states in the East African Community (EAC). In a bid to contribute to the ongoing regional debate on how to harmonize the curriculum, a comparative analysis of the national secondary school mathematics syllabuses of four partner states in the EAC—namely, Kenya, Rwanda, Tanzania and Uganda—was carried out. In this chapter, the results of this comparative analysis, as well as the insights drawn from the analysis are discussed. At the end of the chapter is a discussion of the potential implications of the commonalities, differences and gaps identified in the syllabuses for practice, policy, and future research directions.

Before proceeding further, however, it needs to be acknowledged that there are, broadly speaking, three ways of considering the curriculum: what is intended by policy makers and the authors of the stated curriculum; what is taught by teachers in classrooms; and what actually gets learnt by students (Cuban 1992). One might reasonably consider that the most crucial aspect of the curriculum is the last, that is, what is actually learnt—Tennant and Sarungi in this volume use achievement scores as a proxy for what actually gets learnt by students. This chapter is concerned with one aspect of the intended curriculum; namely, the content of secondary school national mathematics syllabuses in the four countries. In the following section, we describe the intended aims of mathematics education in the four countries.

Stated Aims and Objectives of Secondary School Mathematics Education

In all the four countries, the mathematics curriculum is developed centrally by an independent governmental agency within the Ministry of Education. In Kenya, the curriculum is designed by the Kenya Institute of Curriculum Development; in Rwanda and Uganda, the agency responsible for curriculum development is known as National Curriculum Development Centre (NCDC), while in Tanzania, it is known as Tanzania Institute of Education (TIE). In each of the four countries the mathematics syllabus specifies what topics must be learnt. It also suggests the teaching, learning and assessment materials that teachers could use in their classrooms.

An analysis of the stated aims and objectives of secondary school mathematics curriculum found that some of the aims are country-specific, while others are more general. For example, one of the general objectives for A-level mathematics

education in Rwanda is to enable the learner to "Use acquired mathematical skills to respect human rights" (NCDC–Rwanda 2010: 5)—a recognition of the potential role that mathematics can play in the realm of citizenship and community building. Some goals are shared by some or all the four countries. For example, there are two general objectives that are common to all the four countries, namely, to enable students to:

(i) think and reason precisely, logically and critically in any given situation, and;
(ii) creatively and confidently apply mathematical problem-solving strategies to solve problems in other subject areas and in everyday life.

In addition, there is one general objective that is shared by Kenya, Uganda and Rwanda, namely, to enable students to analyse, interpret and present numerical information meaningfully using tables, graphs, charts, and diagrams. These common objectives could serve as the initial reference points for the harmonization process.

The analysis also revealed that different terminologies have been used by different syllabuses to describe the purpose of teaching mathematics at the secondary school level. Whereas Kenyan and Rwandan syllabuses use only two terms (general objectives and specific objectives), Tanzanian and Ugandan syllabuses use five different terms. In particular, the Tanzanian syllabus uses general competences, class competences, class objectives, general objectives, and specific objectives, while the Ugandan syllabus uses aims, competences, general objectives, specific objectives, and learning outcomes.

In some instances, there seems to be lack of clarity on how the different terms are being used in the syllabuses. For example, in the Ugandan O-level Mathematics syllabus, specific objectives are used to describe what the learners are to achieve by the end of a topic, in the Principal Mathematics syllabus, general objectives and specific objectives are used for topics and subtopics, respectively. In the Subsidiary Mathematics syllabus, meanwhile, learning outcomes and competencies are used for topics and subtopics, respectively. In the Rwandan A-level syllabus, general objectives are used to describe what the learners are to achieve by the end of A-level, by the end of a given year, and by the end of a given topic, while specific objectives are used to describe what the learners are to achieve by the end of a subtopic. In the O-level syllabus, there are no general objectives for topics, instead specific objectives are used to cater for both topics and subtopics.

In moving towards harmonization, it would be helpful to have clarity in the nomenclature used, so that the syllabus makes it clear what is expected of teachers and students and why. This issue is reconsidered in the conclusions. Furthermore, there is need to ensure that the aims and objectives of the mathematics curriculum keep pace with the competencies required in the regional labour market. For instance, ICT skills are very much needed in the current job market, and it would thus be good to have some of the aims and objectives reflect this reality.

Organizing Principles Embedded in the Mathematics Syllabuses

We compared the stated or implied philosophy of secondary mathematics teaching and learning in the four syllabuses, and observed that, generally, the underpinning philosophies in Kenya, Tanzania and Uganda reflect an emphasis on real-world applications of school mathematics. The Kenyan syllabus "has emphasized application of Mathematics to real life experiences and practical approaches to teaching and learning in an effort to address such contemporary issues as information technology, health, gender and integrity" (KIE 2002: 3). The Tanzanian syllabus emphasizes a paradigm shift from a content-based to a competency-based curriculum. The syllabus states that the teaching and learning processes should be student-centered and activity oriented (TIE 2005b: iii). The Ugandan O-level syllabus encourages "practical problem solving" and cooperative learning (NCDC–Uganda 2008: x), while the A-level syllabus emphasizes "effective and efficient acquisition of knowledge and development of concepts, skills, values and attitudes" (p. 119).

Meanwhile, the Rwandan syllabus appears to be content-oriented and prescriptive. In the general introduction, the key topics of the syllabus are listed. The O-level syllabus approaches each topic "in a systematic way while taking into account difficulties it presents and the learning age of the student who receives it" (NCDC–Rwanda 2006: 4), while the A-level syllabus has been prepared "in a format which helps teachers to teach a particular topic effectively" (NCDC–Rwanda 2010: 4). The syllabus underscores the need for an interdisciplinary approach to the teaching of mathematics; in other words, the need to "establish the relationship between Mathematics and other subjects" (p. 7).

In practice, it may be helpful to think of content and process not as antagonistic but, rather, as two sides of the same coin. As such, the match between the stated underpinning philosophy and what happens in the classroom would appear to be a very fruitful area for future research to pursue.

The Place of Mathematics in the Overall School Curriculum

In all the four countries, mathematics has a central and significant place in the school curriculum, as reflected in the number of hours allocated to mathematics (relative to the other subjects in the school curriculum) and the requirement for mathematics to be compulsory for some of the years of schooling.

The secondary education curriculum in Kenya emphasizes both compulsory and elective subjects. In the first and second years, students study 12 subjects whereas in the third and fourth years, they specialize and study between 5 and 9 subjects. Mathematics, English and Kiswahili are compulsory at all levels of secondary education. Performance of students in mathematics and English influences

their admission to various specialized programmes and courses in post-secondary institutions, thus determining their career path (Wasanga, Ogle, & Wambua 2012: 3). In Uganda (Karp, Opolot-Okurut, & Schubring 2014), Tanzania (TIE 2005a) and Rwanda (Republic of Rwanda 2013), mathematics is compulsory up to the end of ordinary secondary education. This means that, whilst Kenyan students have 12 years of compulsory mathematics education, their counterparts in Uganda and Tanzania have 11 years, while students in Rwanda have 9 years. In Tanzania, students who wish to study more mathematics at O-level can take "Additional Mathematics" in addition to the regular mathematics curriculum. The curriculum for additional mathematics is intended for the entire O-level cycle.

During the years of compulsory mathematics education, Kenya is the only country among the four under consideration that has two alternative routes for the secondary mathematics curriculum. Students joining secondary education can choose between 'Mathematics Alternative A' and 'Mathematics Alternative B' curriculum. The latter—a simpler version of Mathematics Alternative A curriculum—was developed in 2009 for students for whom secondary education is terminal or those whose career paths do not require intensive use of mathematics (KIE 2008). The mathematics curriculum is organized into topics and whereas Mathematics Alternative A curriculum has 68 topics, Mathematics Alternative B curriculum has 57 topics. The only new topic in Mathematics Alternative B curriculum is *Cash Books*, otherwise all the other topics are taken from Mathematics Alternative A curriculum. However, as noted in the next chapter, the uptake of Alternative B is extremely low, and it would appear in practice that there is still work to be done in ensuring a meaningful, challenging and enjoyable mathematics curriculum for all learners.

In Tanzania and Uganda, A-level students select a combination of three principal subjects to specialize in according to their interests and career goals. However, students who do not take mathematics as one of their principal subjects but have at least one principal subject that requires some mathematical background—for example, economics or physics—are required to take subsidiary mathematics. This subsidiary mathematics is not as rigorous as the one offered as a principal subject. Until 2014 in Tanzania 'Basic Applied Mathematics' was assessed just on a pass-fail basis, this continues to be the case with the equivalent in Uganda.

It is worth noting here that in Uganda, a project to reform the O-level curriculum is currently underway. According to the National Curriculum Development Centre (NCDC), the proposed curriculum seeks to shift from a strictly academic list of subjects to a set of generic skills that are to be acquired through eight compulsory learning areas; namely, Mathematics, Science, Languages, Social Studies, Creative Arts, Life Education, Religious Education, and Technology and Enterprise (NCDC-Uganda 2014). Currently, the O-level curriculum consists of 14 subjects, and the proposed curriculum framework seeks to merge and integrate these subjects. It is hoped that the new curriculum will provide learners with holistic education that will equip them with the requirements for the contemporary market. With respect to the mathematics learning area, the new curriculum will "move to the applicable and functional mathematics that is required by all learners

for full and effective participation in social and economic life" (p. 3). There will be a core programme of study for all learners and an extended programme designed specifically for high achievers and those going on to further studies in mathematics. A comparison of the current curriculum (NCDC-Uganda 2008) and the proposed curriculum (NCDC-Uganda 2014) would indicate that a number of topics are being dropped, including logarithms as a calculation aid, sets, matrices, functions and linear programming. Algebra is addressed with a noticeably more problem-solving approach. In the absence of any clearly stated timelines for the implementation of the new curriculum, it is the current curriculum which is subject to analysis in this chapter.

Analysis of the Subject Matter Content

Our analysis of the subject matter content in the syllabuses focused on five content strands in mathematics, namely, Number Sense and Operations, Algebra, Geometry, Probability and Statistics (Data Handling), and Measurement. In our analysis of each of these content strands, we were interested in the breadth (the content specified in each of the key ideas) and depth (the degree of emphasis given to the key ideas and the skills specified in relation to those ideas). We were also interested in the grade level at which specific content is introduced. Because of the continuum in mathematics from primary to secondary school, it was necessary to analyze the subject content in the pre-secondary school education as well. Based on this analysis, we identified the disparities and similarities between the syllabuses of the four countries. This section presents the results of the analysis of each of these four content strands.

It is worth noting that it is not always clear when one topic ends and another begins. For example, number sequences might be considered as either a Number Sense and Operations or an Algebra topic; similarly, quadratic equations can be considered both under the headings of Algebra and Geometry. In addition, there are instances where topics are explicitly mentioned in one country but not another, leaving a gap in the intended curriculum which may well be filled in practice. So, for example, place value is not explicitly mentioned in the Rwanda syllabus, and algebraic substitution is not explicitly mentioned in the Tanzanian syllabus. It is also important to reiterate that this was an analysis of the intended curriculum, not the taught curriculum, and still less the learnt curriculum.

Number Sense and Operations

There is a great level of commonality among the four syllabuses in terms of the breadth of coverage of the key concepts in Number Sense and Operations. However, there are differences in depth of coverage as well as in the grade level

at which some of these key concepts are introduced. Table 2.1 shows the year when some of the key skills in Number Sense and Operations are introduced in the mathematics syllabus.

It is noticeable particularly that different syllabuses have different emphases on approximation and estimation. For example, the Kenyan syllabus considers significant figures, absolute, relative, percentage, round-off, and truncation errors, propagation of errors from simple calculation, and maximum and minimum errors. The Ugandan syllabus, on the other hand, focuses on significant figures, decimal places, 'rough' answers, and sensible answers. The Tanzanian syllabus focuses on rounding off whole numbers to given place values; rounding off decimal numbers to a given number of decimal places, writing numbers to a given number of significant figures, and computations involving large and small numbers. For example, in Year 7, there is a discussion of the rounding-off of whole numbers to given place values or to a given number of significant figures. The Rwandan syllabus, meanwhile, has no explicit mention of this area of Number Sense.

It is noticeable that logarithms are still taught in Kenya, Tanzania and Uganda as a calculation aid, whereas in Rwanda they are introduced in the context of calculus. Furthermore, it is only in the Tanzanian mathematics curriculum that the use of ICT and calculators in mathematics is included in the curriculum; otherwise the other three countries do not make explicit mention of integration of ICT in mathematics.

Table 2.1 Year when various skills in number sense and operations are introduced

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Approximation and estimation	11	Not covered	8	8
Number line	9	Not covered	6	1
Fractions	3	2	1	1
Integers	9	7	6	5
Place value	1	Not explicitly covered. There's reference to ones, tens, hundreds, etc.	8	1
Number bases	Not covered	5	8 (only base 10)	5
Roman numbers	5	6	4	4
BODMAS	Not explicitly covered		7	6
Order of operations	9 (on fractions, integers, decimals)		8	
Commutative, associative and distributive laws	Not covered	3	Not explicitly covered	Only commutativity in year 3
Logarithms	10	10	9	9

Algebra

The following shows the introduction of algebra topics by Year across the region, without those topics in which the introduction was in the same Year in all countries (Table 2.2).

Table 2.2 Year when various skills in algebra are introduced

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Use of letters to represent numbers	4	4	5	5
Simplify algebraic expressions	5	6	5	5
Use of > and < symbols	6	8	8	7
Use of brackets	6		9	Not explicitly mentioned
Find value of algebraic expressions through substitution	7	6	Not explicitly mentioned	6
Simplify inequalities in 1 unknown	7	8	8	9
Form and simplify algebraic expressions	8	7	8	9
Factorize algebraic expressions	9	8	9	9
Remove brackets	9	8	9	
Apply algebra to real life situations	9	Not explicitly mentioned	8	3
Solve simultaneous equations	9	9	8	10
Form and solve linear equations in 1 unknown	6	6	6	6
Form and solve linear equations in 2 unknowns	9	(10)	8	10
Form and solve quadratic equations	10	(10)	9	9
Form and solve linear inequalities	10	(10)	Not explicitly covered	11
Transform formulae, constants of proportionality, use to solve problems	10	Not covered	Not covered	10
Arithmetic and geometric progressions	10	4	10	4
Binomial expansions	10	Not covered	Not covered	Not covered
Linear programming	11	Not covered	11	11
Use of matrices to solve simultaneous equations	11	Not covered	11	Not covered
Forming sets (including the empty set)			1	

(continued)

Table 2.2 (continued)

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Comparing sets			2	
Sets: Venn diagrams, membership, inclusion	9	5	5	
Union of sets	9	6	5	
Sets: application to probability			6	
Finite and infinite sets			7	
Sets: formal notation	9	7	8	
Functions: injection, subjection, bisection (sic)		7		
Functions: domain and image	10	7		
Functions: partition		7		
Functions: inverses	10		11	
Functions: composite functions including formal notation		7	11	
Number systems with formal notation: integers, decimals, rationals		7		
Number systems: real		8		
Groups rings and fields		8		
Introductory differentiation	12	(11)	11 (but informally)	
Integration: definite integration	12	(12)	11	
Differential equations	12	(12)		

Note Years in brackets are those not compulsory in Rwanda

There are a large number of commonalities in the sequencing of algebra topics across the countries. For example, letters to represent numerical values is first introduced in Year 4 in Kenya and Rwanda and Year 5 in Uganda and Tanzania. There is similarly at most one year's difference as to when simplification of algebraic expressions are introduced (5 or 6), solution of equations in one unknown (6), finding values of algebraic expressions through substitution (6 or 7), solving quadratic equations by factorization and completing the square (9 or 10), forming and solving linear inequalities (10 or 11) and linear programming, with two years' discrepancy in solving simultaneous equations (Tanzania in Year 8, Rwanda and Kenya in Year 9, Uganda in Year 10).

One key difference is the positioning of number sequences. In Uganda and Rwanda this is in year 4, in Kenya and Uganda in year 10. Particularly in Uganda, there is the clear implication that number sequences are intended to be a means of starting to develop algebraic ideas then to formalize these ideas later. This is not so clear in Rwanda. However, in Kenya and Uganda number sequences are treated very formally from first introduction, consistent with the positioning at a later stage in the school curriculum.

Further differences arise with sets. Forming sets, including the empty set, is mentioned in the Ugandan syllabus in Year 1, with comparison of sets in Year 2. Meanwhile, explicit mention of sets is first made in Uganda and Rwanda in Year 5 and in Kenya in Year 9. In Rwanda, a high level of formality is noticeable from a very early stage. So, for example, 'bijection' comes up in year 7, with groups, rings and fields coming up in year 8. Whilst A-level in Rwanda starts at Year 10, with not all pupils staying on at that stage and not all those that do stay on doing mathematics, the sense of complexity in Rwandan topics continues with internal composition law for groups, rings and fields referred to in Year 10, and the concept of continuity within analysis in Year 11.

Geometry

Table 2.3 shows the year of introduction of geometry topics across the region.

As is the case with the Algebra strand, there is a large amount of commonality, particularly in higher grades, in the treatment of the Geometry strand across the four countries. Angles are first mentioned across the countries in Year 4, with problems with properties of quadrilaterals coming up in Year 7 or 8. In general, there is at most a 1 year difference in application of trigonometry to lengths of sides of right angled triangles (Years 9 and 10) and areas of triangles (Years 10 and 11). Similarity and enlargement are addressed in Years 9 and 10, as are reflection and congruence and areas of parts of circles.

At the early stages of the curriculum, there are large apparent differences as to when topics are introduced. For instance, rectangles, triangles and circles are explicitly mentioned in the Kenyan and Ugandan syllabuses in Year 1, in Tanzania in Year 2 but not until Year 4 in Rwanda. Consistent with this difference is the suggestion in Kenya, Tanzania and Uganda that these shapes be used to make patterns in Years 2 and 3, there is no such suggestion in the Rwandan syllabus.

As with the Algebra strand, a greater formality can be seen in Rwanda, with scalar products in the treatment of vectors in Year 10 and cross product in Year 11. Similarly, whilst calculations in 3 dimensions are explicitly mentioned in the Rwandan syllabus in Year 7, these come rather later in the other countries.

Probability and Statistics

There are noticeable differences among the four countries in the breadth of coverage of the Probability and Statistics strand. In general, the Ugandan and Rwandan syllabuses, on the one hand, cover more key concepts than the Kenyan and Tanzanian syllabuses, on the other.

Differences are also evident in terms of the grade level at which key concepts in this strand are introduced. For example, the Ugandan thematic curriculum includes

Table 2.3 Year when various skills in geometry are introduced

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Straight and curved lines	1		4	
Estimate capacity using containers				1
Rectangles, triangles, circles	1	4	2	1
Ovals	2			
Draw map			3	
Area and perimeter of shapes			3	
Measure angles	5	5	6	5
Reflection (line symmetry)			5	5
Rotations				5
Equilateral, isosceles and scalene triangles	5	4	4	
Parallel lines	5	4	5	6
Properties of rectangles and squares	5			6
Construction for drawing perpendicular and parallel lines, bisecting a line	6		8	7
Vertically opposite and supplementary angles	6	5	8	7
Construction for bisecting angles with applications	6	5	8	7
Construction for triangles	6	6	8	7
Circles: constructions and naming of parts	6		6	
3D: identify cube, cuboid, sphere, cylinder		5		3
3D: surface area and volume		5		
3D: edges, faces, vertices of cubes and cuboids	6		6	9
Circles: pi and circumference and area		6	8	
Construction circle from vertices of triangle	7	7		
Pythagoras	7	Not explicitly mentioned	7	6
Models of cubes, cuboids, cylinders	7			
Construct circle touching edges of triangle	8			
Problems with Pythagoras	8			
Construct parallelograms and rhombuses	8			
Properties of quadrilaterals	8	7	8	
Triangular and square based pyramids	8			
Cartesian plane, including graphical solution of simultaneous equations	9	8	6	8
Parallel projections, central symmetry		8		
Solve problems with angles	9			8
Constructions including bisector of lines, parallel lines, regular and irregular polygons	9			
Reflection (line and plane symmetry)	10			

(continued)

Table 2.3 (continued)

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Rotation	10	8	9	
Translation			9	
Surface areas of solids	10			
Volumes of solids	10		6	
Trigonometry: all angles	11			9
Circles: lengths of arcs and chords; tangents; traversals	11	8 (Thales theorem)	10	8
Vectors	11	8	11	9
Solve quadratic and cubic equation graphically	11			8
Loci	12			8
Graphs of form sin(ax + b)	12	10		11
Calculations in 3D	12	7	11	9
Great and small circles	12		10	
Longitude and latitude	12		10	
Midpoints on lines			11	

basic bar charts in Year 2, while in the other countries, these are covered much later. Similarly, probability is introduced in year 7 in Uganda, 9 in Kenya, 11 in Tanzania and 12 in Rwanda.

There are also differences in the terminologies used to refer to this strand in the Ugandan syllabus at different stages of the mathematics curriculum. For example, during the primary school years, it refers to it as "Data Handling" or "Interpretation of Graphs and Data"; while at the secondary school level, it is called "Statistics". Table 2.4 shows the results of our comparative analysis

Table 2.4 Year when various skills in data handling/statistics are introduced

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Collect and organize/record data	4	6	9	2
Bar graph/bar chart	5	6	4	2
Pie chart	10	6	6	7
Line graph	6	Not mentioned	6	4
Mean/average	6	5	5	5
Median	8	8	10	6
Mode	7	5	10	6
Quartile	12	9	(13)	(12
Range	12	(10)	Not covered	(12)
Standard deviation	12	(10)	(13)	(12)
Interquartile range	12	(10)	Not covered	(12)
Probability	9	(12)	11	7

of the syllabuses in terms of year when some of the key skills in Statistics and Probability are introduced in the mathematics curriculum.

In Tanzania, quartiles and percentiles are presented in year 13 as measures of dispersion (TIE 2009a: 48) when, in fact, they are not; they are measures of position/location. In the Subsidiary Mathematics syllabus, quartiles and percentiles are presented as measures of central tendency (TIE 2009b: 22).

Measurement

Compiling the table below necessitated, rather more than in the other content areas, making judgements as to the equivalency of wording in the different syllabuses. Gaps in the table indicate a lack of explicit mention, which does not, of course, necessarily mean that the area is not covered.

As shown in Table 2.5, there are very few similarities in measurement between all four countries.

Distance/time graphs get introduced in either Years 6 or 7 and time in hours and minutes appear in Year 4. Apart from these examples, it is the differences between the countries which are most noticeable.

There is no mention of measurement topics in the Rwandan syllabus before Year 4, with no suggestion that, for example, informal units be used to measure length as there is in the other three countries.

Consistent with the thematic curriculum in Uganda in the early stages of the primary school, measurement topics are well represented in the first three years, with Kenya also showing a large number of informal topics.

Money calculations are not explicitly mentioned in the Rwandan syllabus, with differences in the timing of introduction in the other three countries, with adding and subtracting in units of 1000 shillings appearing in Year 3 in Kenya, 2 in Uganda and 1 Tanzania (albeit that 500 shillings are also mentioned in Kenya and Uganda at this time). It is, of course the case that the same numerical values have different monetary values in the different currencies, although there is no clear pattern to explain this.

It is noticeable also that somewhat different contexts are given at different stages for financial topics. So, invoices are mentioned in Year 4 in Tanzania but not followed up thereafter, double entry accounts in Tanzania in Year 10, whilst taxation as a topic appears in Kenya in Year 11 and Uganda in Year 10.

Implications of the Findings

A number of key points come out of the analysis above. It is particularly the Rwandan syllabus which, as noted above, is defined largely by content, which adopts a formal approach, excluding approximation of number and including

Table 2.5 Year when various skills in measurement are introduced

	Year when the skill is introduced			
	Kenya	Rwanda	Tanzania	Uganda
Comparison of people, weights and lengths				1
Non-standard units	1		3	1
Times of day	1			1
Capacity of containers	1			1
Months of the year			*1* (*in language*)	1
Use coins	1	4		
Add/subtract shillings in 500 and 1000 denominations	3		1 (100 s TSh)	2
Use a calendar	2	4	5	2
Measure in length	4	4	4	4
Measure in time	3	4		2
Measure in litres	3	4		2
Make a simple budget				3
Personal timetable				3
Weight in g and kg			3	3
Generate an invoice	5 (a bill)		4	
Problems in time, distance, speed				5
Net mass, gross mass, tare				5
General calculations with money				5
Profit and loss				5
Convert from one currency to another	9		10	6
Temperatures	7			
Area in m^2 and cm^2	5	4		
12/24 h clock time			6	7
Timetables	9			7
Calculate volume	5	8	7	7
Commercial arithmetic				8
Density	9			
Bearings				8
Distance-time graphs	10			8
Simple and compound interest	6		8	8
Hire purchases and mortgages	7			10
Taxation	11			10
Double entry accounts, balance sheets			10	

topics in year 8 which would in other countries be considered to be A-level topics or even undergraduate. According to Uworwabayeho, Rubagiza, & Iyamuremye (2007) the previous Rwandan syllabus was overloaded, content driven, trying to engage all children in the secondary sector with what only the very highest

attainers were doing in the USA. This analysis would seem to suggest that there is the need to revisit these issues in ensuring a syllabus which meets the needs of all youngsters in school for the 21st century, although such a suggestion needs to be cross-referenced against research as to pupils' experience within mathematics in Rwanda, both qualitative and quantitative.

The extent to which there are connections between different aspects of mathematics, particularly number and algebra, and also algebra and geometry, also varies from country to country. Uganda's thematic curriculum for the primary sector, with the spirit of it largely being continued in the proposed new secondary curriculum (NCDC-Uganda 2014) would, in principle appear to be a starting point for exploring connections between different aspects of mathematics and, indeed, with other subjects and 'real life'.

It would be consistent with a thematic or competency-based approach to question what actually matters in terms of content coverage. So, for example, one might reasonably consider that many geometry topics—for example, shape work, transformations, symmetry, loci, constructions, angles—can be introduced informally at a very early stage in the mathematics curriculum, with links made with art, shapes that one sees around the school room and beyond. A corollary of this is that one may not wish to put much significance on the difference in Year, for example, in which rectangles, triangles and circles are specifically mentioned, as a later introduction may well mean a more formal treatment, and it is possible that these concepts are mentioned at an earlier stage informally even if not on the curriculum.

From this perspective the differences in what is addressed at the early stage of the school curriculum could be considered to be arbitrary, that it is how topics are approached is more important than exactly what is approached and when. This would suggest the need for additional research as to children's experience in these topics, and how teachers can best be supported in ensuring that children have a clear sense of progression in an interesting and motivating mathematical environment.

In making strong links between the mathematics classroom and the outside world, the handling of finance could usefully be rethought across the region. There is clear opportunity to practise basic arithmetic routines through money calculations, and also to make links with other subjects and life outside of school. The need for children to be doing calculations in both shillings and cents in Kenya and also Tanzania could usefully be rethought in terms of ensuring that the mathematics taught in classrooms is aligned with that actually used in the outside world. Also, whether the examples of applications of financial topics given relate meaningfully to pupils' experience needs to be questioned in working towards a syllabus fit for all children in the 21st century.

Conclusions

As earlier noted, this was an analysis of the intended curriculum and as such, it needs to be supplemented with research into the taught and learnt curricula. Some of the issues emerging from this analysis call for a thorough debate among mathematics educators and researchers. For example, there is need to examine the position of logarithms as a calculation aid, particularly against a backdrop of the pressures of an overloaded curriculum and the rhetoric of the need to embrace ICT, including calculators, as a valuable tool for mathematics learning. There is also a challenge raised of how to ensure that the mathematics curriculum represents the needs of all learners and not just the few. This would lead to the question of how long mathematics should be made compulsory with, as noted earlier, different answers given across the region.

It is clear from this analysis that a great deal of work has been done in the four countries considered to enhance mathematics education and students' experiences in the classrooms. It may well be considered that a major benefit of harmonization across the region would be to harness these efforts to make mathematics relevant and meaningful, recognising the need to accommodate all learners and not just a few, in order that students' learning experiences be enhanced to the benefit of themselves, their communities, their countries and the region of East Africa.

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