Mathematics achievement in South Africa: A comparison of the official curriculum with pupil performance in the SACMEQ II Project – MQ Moloi

South Africa participated in the Southern and Eastern Africa Consortium for Monitoring Educational Quality study (SACMEQ II). SACMEQ came up with a radical shift from the traditional way of reporting learner achievement in mean scores and used the Rasch model to organise and report leaner achievement in a hierarchy of competencies from the simplest to the complex. Around 80% of South African grade 6 learners in the study reached the lower half of eight levels of competence in mathematics on the SACMEQ continuum. The lowest levels of competency were observed among learners in rural schools. In the main these were also schools where the lowest levels of resources were reported and infrastructure was inadequate. Analysis of local textbooks of mathematics showed significant gaps between what texts presented and what the official curriculum requires. This had serious implications given that textbooks are often the only resource available particularly to the disadvantaged rural schools. The considered view in this paper is that, although textbooks may not be the sole cause of poor learner performance, the relevance of learner support materials is a matter that needs to be prioritized. Finally, this analysis demonstrated the value that SACMEQ, as a monitoring mechanism for quality education, can add to providing relevant information for policy decision-making.

Introduction

In 2000 South Africa participated in the second study conducted by the Southern Africa Consortium for Monitoring Educational Quality (SACMEQ), a project popularly known as SACMEQ II, in which 15 countries from southern and eastern Africa participated. A random sample of 3 416 grade 6 learners from 169 South African public schools was tested in reading (literacy) and mathematics (numeracy). The learners performed particularly poorly in mathematics. SACMEQ II Project tests were constructed carefully so as to ensure that the structure of the learner tests was congruent with the content and skills derived from detailed analyses of the curricula, syllabi, examinations and textbooks used in the SACMEQ countries. A full account of the process and the findings of the study have been documented in the South African report on the SACMEQ II Project (Moloi and Strauss, 2005).

In the period of data collection South Africa was in the process of reviewing her curriculum with a view to strengthening and making it accessible to all learners and ensuring that learning outcomes are relevant and are of a high quality. In this paper an outline of the process and the findings of a secondary analysis that was conducted on the South African SACMEQ II mathematics data is reported. The purpose of the analysis was to investigate whether and how learners' achievement of SACMEQ mathematics competencies translated into achieving or not achieving the outcomes specified in the strengthened South African mathematics curriculum. The analysis included a probe into a few contextual factors which might impact on learners' achievement of the curriculum outcomes.

Like many countries of the world, particularly developing countries, South Africa is faced with a challenge to overcome a critical shortage of mathematics teachers as well as to develop a mathematically-skilled workforce in various fields. On the supply side, statistics released by the Department of Education showed that only three percent of all the students enrolled in institutions of higher learning in the year 2000 were in mathematical sciences as an area of specialization (Department of Education, 2005). In prefacing a National Strategy for Mathematics, Science and Technology for 2005-2009, the Department (2004) took cognizance of this limitation and further expressed concern that the teaching of mathematics in schools was often never a first choice to talented mathematics graduates. Consequently, mathematics was often taught by inadequately qualified teachers and this led to a vicious cycle of poor teaching, poor learner achievement and a constant under-supply of competent teachers (2004:10).

On the demand side, labour statistics showed that, in the same period, only about nine percent of employed South Africans aged 15-65 years were in occupations that require some mathematical competence, for example, technicians and associate professionals (Department of Education, 2004). In the medium to long term, this is too modest a human capital to sustain an economy which has shown a phenomenal 4.8 percent growth spurt in the last five years.

Evidently, the current demand for mathematically competent potential workers in the country outstrips both the quantitative (outputs) and qualitative (achievement) supply by far. This paper posits that, any strategy to stem the tide of mathematical skills deficiency in the country must be underscored by broadening participation and ensuring measurable quality outcomes in mathematics at the basic education and training (GET) band of the education system.

Background

Historically, the apparently unceasing shortage in both intake and success in school mathematics in South Africa has been largely blamable on a curriculum that was patently skewed in favour of a small minority of learners who would proceed to university training in areas such as engineering, manufacturing, medicine and other so-called ‘hard skills’. It provided little to no opportunity to learners who only needed to apply mathematical skills in ordinary life situations. The curriculum was heavily content-laden, encouraged rote learning of mathematical techniques and algorithms and lent itself to very little application in everyday experiences of learners.

Besides the universally known cognitive challenges that learners have to contend with in learning mathematics, in South Africa the then apartheid regime made access to this learning area particularly difficult on three fronts. Firstly, discriminatory provision for education on the basis of race limited severely the availability of adequate and appropriate resources for Black learners who constitute the absolute majority of the learner population in the country. Secondly, whatever learning support materials (LSM), particularly textbooks, were available were based on western philosophies and were found not adaptable to local indigenous knowledge systems (IKS). The locus of the underlying pedagogy was on teaching rather than learning. Consequently, the curriculum was packaged into time-bound subject syllabi which required highly contrived and theoretical contexts in order to be accessed cognitively.

Thirdly, the use of imposed foreign languages for instruction affected the acceptability of the curriculum, made learning in general very difficult and learning of mathematics in particular virtually impossible.

The strengthened outcomes-based curriculum

A transformational measure taken by South Africa since the advent of the constitutional democracy in 1994 was to identify national critical outcomes and corresponding mathematical learning outcomes as a basis for a curriculum that is learner-centred, relevant and assessable in terms of a hierarchy of demonstrable and measurable competencies. The curriculum purports to instill in learners *critical outcomes* that are defined as '*core life skills for learners such as communication, critical thinking, activity and information management, group and community work, and evaluation skills*' (Department of Education, 2002).

Critical outcomes derive their context from the various learning areas (subjects) which comprise the curriculum. Thus mathematics as a subject or learning area provides a context from which mathematical dimensions of the critical outcomes, mathematical learning outcomes, derive. In a process that involved educational specialists as well as key stakeholders, the

Department of Education (2002) identified five learning outcomes for mathematics and their intentions as far as learners are concerned can be paraphrased as follows:

1. *Learning Outcome 1 (Numbers, operations and relationships)*: Ability to recognize, describe and represent numbers and their relationships, to count, estimate, calculate and check with competence and confidence in solving problems.
2. *Learning Outcome 2 (Patterns, functions and algebra)*: Ability to recognize, describe and represent patters and relationships, as well as to solve problems using algebraic language and skills.
3. *Learning Outcome 3 (Space and shapes)*: Ability to describe, and represent characteristics and relationships between two-dimensional shapes and three-dimensional objects in a variety of orientations and positions.
4. *Learning Outcome 4 (Measurement)*: Ability to use appropriate measuring units, instruments and formulae in a variety of contexts.
5. *Learning Outcome 5 (Data handling)*: Ability to collect, summarize display and critically analyze data in order to draw conclusions and make predictions, and to interpret and determine chance variation.

Because by their nature both critical outcomes and learning outcomes are fairly broad aspirations, for assessment purposes each learning outcome is further defined in terms of a hierarchy of specific competencies referred to as *assessment standards*. Assessment standards are defined as '*the knowledge, skills and values that learners need to show to achieve the Learning Outcomes in each grade*' (Department of Education, 2002). They also suggest minimum mathematics content that learners must command to show that they have achieved the learning outcome.

The clustering of assessment standards is such that, given any task that a learner completes successfully, one is able to make judgments, based on the requisite assessment standards which the learner explicitly or implicitly deploys on the task, to decide the grade at which such a learner operates. Alternatively, given a set of prerequisite assessment standards, one can develop or select tasks that are appropriate for learners at a given grade.

By elevating outcomes over subject or learning area content, the curriculum is rendered amenable to delivery in diverse contexts. It therefore provides a multi-track pathway to learning. That is, learners should be able to achieve the outcomes regardless of the context in which they learn.

SACMEQ levels of competence

In a parallel process, SACMEQ initiated a radical shift from the traditional way of reporting learner achievement in mean scores and used the Rasch model to organize and report learner achievement in a hierarchy of competencies from the simplest to the complex. The process of defining SACMEQ competency levels and developing reading and mathematics test items that fitted each level and subsequently auditing the requisite competencies for learners to successfully respond to the test items has been fully described in SACMEQ II national reports.

For mathematics the process culminated in a hierarchy of eight levels of competency. An elaborate skills audit enabled SACMEQ researchers to place clusters of items in different levels of competence such that items in each cluster '*had similar difficulty levels* <u>*and*</u> *shared a common 'theme' with respect to the underpinning competencies required to provide correct responses*' (Moloi and Strauss, 2005). An intensive discourse among the researchers led to a consensus on descriptive names that summarize the theme of each level of competence.

A comprehensive account of the eight SACMEQ mathematics levels has been documented in Moloi and Strauss (2005) and other SACMEQ member countries' reports on the SACMEQ II Project. A brief summary of the competencies that characterize each level have been listed as follows:

1. *Level 1 (Pre-numeracy)*: Applies single step addition or subtraction operations. Recognizes simple shapes. Matches numbers and pictures. Counts in whole numbers.
2. *Level 2 (Emergent numeracy)*: Applies a two-step addition or subtraction operation involving carrying, checking (through very basic estimation), or conversion of pictures to numbers. Estimates the length of familiar objects. Recognizes common two-dimensional
3. *Level 3 (Basic numeracy)*: Translates verbal information (presented in a sentence, simple graph or table using one arithmetic operation in several repeated steps. Translates graphical information into fractions. Interprets place value of whole numbers up to thousands. Interprets simple common everyday units of measurement
4. *Level 4 (Beginning numeracy)*: Translates verbal or graphic information into simple arithmetic problems. Uses multiple different arithmetic operations (in the correct order) on whole numbers, fractions, and/or decimals
5. *Level 5 (Competent numeracy)*: Translates verbal, graphic, or tabular information into an arithmetic form in order to solve a given problem. Solves multiple-operation problems (using the correct order of arithmetic operations) involving everyday units of measurement and/or whole and mixed numbers. Converts basic measurement units from one level of measurement to another (for example metres to centimetres)
6. *Level 6 (Mathematically-skilled)*: Solves multiple-operation problems (using the correct order of arithmetic operations) involving fractions, ratios, and decimals. Translates verbal and graphic representation information into symbolic, algebraic, and equation form in

order to solve a given mathematical problem. Checks and estimates answers using external knowledge (not provided within the problem)

7. *Level 7 (Concrete problem-solving)*: Extracts and converts (for example, with respect to measurement units) information from tables, charts, visual and symbolic presentations in order to identify, and then solves multi-step problems
8. *Level 8 (Abstract problem-solving)*: Identifies the nature of an unstated mathematical problem embedded within verbal or graphic information, and then translate this into symbolic, algebraic, or equation form in order to solve the problem.

Items pitched at SACMEQ levels 7 and 8 were meant for teachers but were also administered on learners. The overlap in items was deliberately intended to facilitate a comparison of teachers' and learners' performances in the items that were common. In South Africa teachers were not tested and, therefore, no such comparisons could be made.

The research problem and questions

Whilst South Africa was able to successfully rid her mathematics curriculum of inordinate content load and to also purge it from all racial biases, systemic evaluations conducted by the Department of Education, first at Grade 3 in 2001 and later at Grade 6 in 2004, revealed worrying deficiencies in learners' reading, writing and numeracy skills (Department of Education, 20003). Other than the 'dipstick' surveys that have pointed to low levels of achievement in numeracy, there has been no systematic attempt to research whether the curriculum is now accessible to all learners from all different contexts - urban and rural and from different socio-economic strata -, such that success through the schooling system can be guaranteed to all learners.

Within the limitations of the South African SACMEQ data, the objective of this paper, therefore, was to investigate whether the grade 6 learners who participated in the SACMEQ II project displayed competencies that were appropriate for their grade in terms of the assessment standards in the mathematics national curriculum. The investigation was stretched to include possible contextual factors that might influence performance in mathematics.

While official curricula generally point to the ideals and aspirations of education systems, in the final analysis it is what is taught and learnt in the classroom (the implemented curriculum) that eventually translates into observable and measurable outcomes - intended or otherwise. Besides learner characteristics (e.g. gender, age, intelligence), access in terms of the availability, adaptability and acceptability of learning support materials constitutes one major determinant of the level and quality of learner achievement. There is also awareness of how socio-economic contextual factors can hinder or support access to and success in the curriculum (UNESCO, 2005; Ross and Zuze, 2004). In South Africa in particular, broad participation (access) and quality achievement in mathematics have been prioritized for equity and general redress of historical inequalities (Department of Education, 2004).

The focus of this paper, therefore, was in answering the following research questions:

1. To what extent did grade 6 learners achieve the competencies prescribed in the official mathematics curriculum in South Africa?
2. Do learners have equal access to the curriculum to enable them to achieve the expected competencies?
3. Do available learning support materials, with special focus on textbooks, adequately reflect the outcomes in the curriculum?

The significance of answers to these questions derives from an increasing recognition that the traditional approach of analyzing and reporting learner achievement in all-embracing average scores conceals critical information that would enable education systems to 1) identify genuine learning challenges faced by children at early stages of the schooling ladder and 2) mount appropriate interventions to sharpen learners' readiness for subsequent grades.

Appropriate analyses were executed, firstly on South African SACMEQ II data archive to determine the levels of performance of the sampled learners and, secondly, on a few selected grade 6 mathematics textbooks to determine how these resources reflected the curriculum and thus conjecture how they could possibly influence the extent to which learners achieve the expected competencies and outcomes.

Matching SACMEQ levels with South African grade levels

To answer the first research question: 'To what extent did grade 6 learners achieve the competencies prescribed in the official mathematics curriculum in South Africa?', the author mapped the SAMEQ II mathematics competencies against the assessment standards in the official mathematics curriculum. This was made possible by the fact that both SACMEQ and the official curriculum documents provide clear examples to illustrate each competency. In both cases the competencies are organized in a hierarchy from the simple to the complex. The SACMEQ hierarchy spans 8 levels while the curriculum ranks competencies according to the school grade from grade R (reception year for 0-5 year olds) to grade 9.

A level-by-level analysis of SACMEQ competencies and the grade levels in the curriculum threw up identifiable similarities between the two sets of competency hierarchies. The emerging similarities were found to lend themselves to meaningful interpretation of learner performance in either hierarchy. By matching SACMEQ competencies with the assessment standards in the curriculum, it became possible to map the performance of South African learners on SACMEQ II mathematics onto the national mathematics curriculum.

It must be noted that no neat one-to-one correspondence was found between the two sets of competencies. Some SACMEQ competencies straddled more than one grade in terms of assessment standards and vice versa. Where this happened, the grade was matched to the level with the greatest overlap between SACMEQ competencies and the corresponding assessment standards. For instance, if a SACMEQ level comprised competencies that spanned grade 3 and grade 4, but it was found that more SACMEQ competencies matched grade 3 assessment standards, judgment was made in favour of grade 3.

The mapping showed that, although there was no across-the-board one-to-one matching of SACMEQ levels to school grades in terms of the required competencies, most of the school grades could be linked to SACMEQ levels. The pattern that emerged from this matching has been summarized in Table 1.

A few examples are discussed in fair detail below to illustrate the process that was followed to map SACMEQ competencies to the South African curriculum outcomes and assessment standards.

Example 1, Items 34 (*pmath34*), 1 (*pmath01*) and 3 (*pmath03*): Item 34 (*pmath34*) tested whether the learner could 'count illustrated objects'. Items 1 (*pmath01*) and 3 (*pmath03*) tested the learner's ability to 'Carry out single operations of subtraction and addition', respectively. Item 1 involved subtraction and two-digit numbers. Item 3 involved addition and up to three-digit numbers. According to the SACMEQ levels of numeracy competence, a learner who successfully answered an assortment of items of the type of items 34, 1 and 3 could be considered to be operating at the 'Pre-numeracy' level. General competencies that characterize learners at this level are that the learner: 'Applies single step addition or subtraction operations. Recognises simple shapes. Matches numbers and pictures. Counts in whole numbers'.

A corresponding analysis according to the South African curriculum shows that the learner above meets the requirements of a learning outcome on 'Numbers, operations and relationships' and displays assessment standards that characterize grade R (item 34), grade 1 (item 1) and grade 2 (item 3).

The grade R assessment standard specifies that the learner 'Counts to at least 10 everyday objects reliably' as was required to successfully complete item 34. The grade 1 assessment standard specifies that the learner 'Can perform calculations, using appropriate symbols, to solve problems involving addition and subtraction of whole numbers and solutions to at least 34'. The grade 2 assessment standard is the same except that learners must be able to handle numbers with more than two digits. The SACMEQ Pre-Numeracy level therefore spanned the grades R, 1 and 2) as reflected in Table 1.

Example 2, Items 50 (*pmath50*) and 9 (*pmath09*): The two items tested whether the learner 'Interprets simple common everyday units of measurement' of time (item 9) and of temperature (item 50). Learners who successfully completed a cluster of items of this type were considered to have attained the 'Basic Numeracy' SACMEQ level. According to SACMEQ, typical competencies associated with this level include the ability of the learner to 'Translate information (presented in a sentence, simple graph or a table) using one arithmetic operation in several repeated steps. Translates graphical information into fractions. Interprets place value of whole numbers up to thousands. Interprets simple common everyday units of measurement'.

According to a corresponding analysis in terms of the South African curriculum, the learner who successfully answered items 50 and 9 meets the requirements of the learning outcome on 'Measurement' with an assessment standard which specifies that achievement of this outcome at this level will be evident when the learner 'Uses appropriate measuring instruments to appropriate levels of precision including thermometers to measure temperature'. Learners who displayed competencies required to successfully complete an assortment of items of the type of items 50 and 9 are considered to operate at the level of grade 5. Grade 5 numeracy competencies were therefore categorized as equivalent to the SACMEQ 'Basic Numeracy' level as shown in Table 1.

As can be seen from the given examples, matching of SACMEQ levels with South African grades was also made possible by the fact that, while the curriculum prioritizes outcomes over content, the assessment standards do suggest, in non-prescriptive terms, minimum concepts that must be developed. While this flexibility may have value in terms of allowing for the contextualisation of mathematics learning and teaching, it does also present a challenge to the level of professional competency and innovation that are demanded from teachers. Similarly, there are challenges in terms of the type and amount of content that should be included in learner support materials, especially textbooks which normally remain in circulation for a minimum of three years.

Key findings on learner achievement

A matching of the SACMEQ levels of competence with the assessment standards in the official curriculum showed that, of the 3 416 South African grade 6 boys and girls who took the SACMEQ II mathematics test, nearly 80 percent had not acquired the apposite competencies in mathematics.

Learner achievement of expected competencies

Analysis of SACMEQ data for South Africa was conducted to find 1) the overall performance of learners in mathematics and 2) to determine the percentage of learners achieving various SACMEQ levels.

On a Rasch scale with SACMEQ mean score of 500 and standard deviation of 100, the South African mean score in mathematics was 486, more than one standard deviation below the SACMEQ mean. The percentages of learners who achieved various SACMEQ levels have been shown in Figure 1.

The modal level of competence was Emergent numeracy which, according to corresponding assessment standards in the curriculum, is the equivalent of grade 3. So, just over 44 percent of the learners who had been in school for at least six years , could be said to be performing at the level of a child who has been in school for three years. About 24 percent performed at the Basic numeracy level which is the equivalent of grade 4, nearly nine percent at the Beginning numeracy level (grade 5) and only six percent performed at the Competent numeracy level (grade 6). The percentages diminished up the competency ladder and only about one percent of the learners achieved the Independent numeracy level which was considered to equivalent to grade 7 or higher.

Achievement of learners in different locations

The achievement of learners was also analyzed according to the location of the school that they attended. Using indicators such as access roads, availability of amenities and facilities, schools were categorized into city, small town and rural schools. Learner achievement of the SACMEQ levels have been shown in Figure 2 for each of the three locations. Overall, there were worryingly wide differences in achievement with the worst by learners who attended school in rural settings.

A significant majority of rural learners could only achieve Pre-numeracy (11,8%) and Emergent numeracy (59,6%) levels which are equivalents of grade 2 or lower and grade 3, respectively. About 23 percent achieved SACMEQ level 3 (Basic numeracy) or grade 4. None of them achieved level 8 (Independent numeracy). City learners mainly achieved levels from 2 to 6 in fairly comparable percentages. Twenty percent of them achieved level 2 (Emergent numeracy or grade 3) and just over 17 percent achieved level 6 (Concrete problem-solving or the equivalent of grade 7).

Achievement of learners from different socio-economic statuses

SACMEQ researchers constructed an index for “Possessions at home” and used this as a proxy for the socio-economic status (SES) of the child. The index comprised of reading and electronic items such as monthly magazines, newspaper, cassette player, video cassette recorder and a telephone. The index ranged from 1 to 14 and learners whose homes possessed less than half of the items were classified as of a low SES. Those who possessed more than half the items were classified as of a high SES.

The percentage of learners who achieved various SACMEQ levels in mathematics as well as their socio-economic status have been shown in Figure 3. Generally, learners from high SES achieved higher levels of competence than their counterparts from low SES. The majority of the low SES learners (65,6%) achieved SACMEQ levels 1 (Pre-numeracy) and 2 (Emergent numeracy), equivalents of grades 2 and lower and 3, respectively. About twenty six percent of low SES achieved SACMEQ level 3 (Basic numeracy) and roughly two percent achieved level 5 (Competent numeracy or grade 6).

Among themselves high SES learners achieved all eight SAMEQ levels of competence in mathematics with percentages tapering off to almost three percent at the Abstract problem solving level (grade 7+). Thirty four percent were at level 2 (grade 3), 22 percent at level 3 (grade 4), about 12 percent at level 5 (grade 6), ten percent at level 6 (grade 7), four percent at level 7 (Grade 7 ++) and about three percent at the Abstract problem solving level (much higher than grade 7).

Altogether just over 27 percent of high SES learners achieved equivalent of grade 6 grade 6 competencies compared to just less than three percent of their low SES counterparts.

Do available school textbooks adequately reflect curriculum ideals?

Textbooks play an important role in ensuring access to and success within what the schooling system offers. In poor communities it often happens that the school textbook is the only learner support material in print to which learners have access. In the SACMEQ study about 90 percent of the South African grade 6 learners indicated that they either had a mathematics textbook to themselves or shared one with someone else. Textbooks should, therefore, as accurately as possible, communicate the ideals of the curriculum and purvey images of what society expects from those who go through the schooling system.

To answer the last research question in the focus of this paper: 'Do available learning support materials, with special focus on textbooks, adequately reflect the outcomes in the curriculum?, the author analysed three grade 6 mathematics textbooks that were used in schools in South Africa. The analysis was meant to establish, at an admittedly superficial level, the extent to which textbooks reflect the intended outcomes of the curriculum and whether they were user-friendly enough to impart relevant messages to readers. As a rule, in South Africa individual public schools select textbooks from a list that has been approved by the Department of Education.

Three mathematics textbooks were subjected to the analysis. For the purposes of this paper, they are simply referred to as Textbook A, Textbook B and Textbook C. The author first set the criteria for analyzing the textbooks. These were a) the language of the textbook, b) the volume in terms of the number of text pages, c) the proportion of pages with pictures as distinct from diagrams and figures, d) the proportion of text that reflects mathematics as a social enterprise and not just an abstract academic exercise, e) the proportion of the text that was dedicated to reflecting local examples and f) whether the textbook had a glossary of new words.

The author then mechanically went through each textbook to test it against the set criteria. The findings of the analysis have been summarized in Table 2. The observations that follow were made from Table 2.

All the textbooks were written in English which, to the majority of South African children would be a second or third language. It should be noted that, even though by law in South Africa schools can choose any one of the eleven official languages as a medium of instruction, most schools prefer to use English for instruction and learning. More than 80 percent of South African grade 6 learners in SACMEQ indicated that they only “sometimes” speak English at home. Evidently the odds should be weighed heavily against children who must face a double challenge of learning mathematics as a challenging subject and do so in a language that is foreign to them.

The textbooks varied in volume from 140 to 226 text pages. This excludes cover pages. The proportion of pages with at least one picture on a page varied from 65,2 percent in Textbook B, 46,9 percent in Textbook A to 27,1 percent in Textbook C. While there may be no clear acceptable minimum proportion that a book must comply with, Textbook C had too few pictures to reflect to the reader the unwritten contextual issues that may impact on realizing the outcomes of the curriculum.

Pictures improve the readability of the text. They reduce the inherent boredom of reading words and numbers, enable the reader to make necessary associations among what the text says, what they see in the picture and what they already know. Selected judiciously and used carefully, pictures have an enormous potential to add value to learners’ own constructed knowledge.

In all the three textbooks, an even more limited space was given to pictures that reflect mathematics as a human enterprise in real life situations. Most of the pictures were simulations of what happens in classrooms rather than real life contexts. Proportions varied from 48,5 percent in Textbook B, 27,8 percent in Textbook A and 9,3 percent in textbook C.

As far as using local examples is concerned, the situation was even grimmer. Local in this case referred to the wider African context rather than South Africa. The names of persons, places and activities that were used as examples in setting the scene for a particular idea were very much atypical and removed from the local setup. Textbooks A and B each had about 3 percent of examples taken from local contexts and for Textbook C the proportion was about two percent.

Only Textbook C had a glossary of new words. The glossary can serve a great purpose in assisting both teachers and learners to understand the message of the book. Its absence may discourage potential readers from interacting with the text.

It must be acknowledged that the number of textbooks that were analyzed is fairly small relative to all the mathematics textbooks that may be in circulation in the South African schooling system. Textbook B, which dedicated the largest proportion of its volume to representing mathematical information in pictorials, drew the highest percentage of its content from social contexts but was the only one without a glossary of new words, was used by more than 50 percent of the schools that were contacted in one of the largest townships around the capital city of Pretoria.

The other two books were used by almost the same number of schools, and these were fairly few. But the fact that the three textbooks were collected from three different schools is indicative of some significant usage of these texts in many other schools. Time constraints did not allow a more incisive analysis in terms of the teaching methods and learning styles that underpin the assumptions of the textbook authors. It would also be valuable to analyze the books in terms of the skills that they portray.

But what emerges from the analysis are critical issues of interest to curriculum implementation. Largely, texts tend to be focused on content contrary to the directives of the curriculum to focus on outcomes. Arguably, learners need some basic conceptual framework around which to make sense of the mathematics world and develop the necessary outcomes. However, if no balance is maintained between content and context, learners may be estranged from the subject and develop negative attitudes, which in turn may affect their performance and achievement.

The suitability of textbooks may be an issue for a universal debate even in systems where the language of the learner is the same as that used in the textbook. But the fact that in this case the textbooks are written in a foreign language exacerbates the situation. It presents not only learning problems, but also teaching challenges since teachers of mathematics must of necessity also teach the language. Their competency in this regard may be another issue to be investigated.

Conclusion

Two main conclusions can be drawn from this discourse. The first one is about the value that SACMEQ methods of educational evaluation can add to improving curricular of participating education systems. The second conclusion pertains the performance of learners in mathematics and what the implications for curriculum are. Each of the is worth commenting on.

About SACMEQ methods of evaluation

The radical change to report learner achievement in terms of levels of competencies is in tandem with the move towards outcomes-based education. In many systems of education in Africa the intention to move away from content-based syllabi to measurable outcomes has been expressed loud and clear. The challenge has always been the implementation of these ideals. SACMEQ provides a possibility which may be explored further and used to benefit both the systems and the learners who go through these systems. Knowing the levels at which learners performance can be a useful tool to predict performance in subsequent classes and providing appropriate interventions. This enhances significantly the value of SACMEQ as a mechanism for monitoring educational quality in the member country systems of education.

About learner achievement and the curriculum

Alongside challenges of social transformation, South Africa faces a challenge of improving the quality of learning outcomes particularly in mathematics. In this paper it has been shown that, although there is overall unsatisfactory achievement of outcomes by learners of mathematics, the problem affects certain sectors of the population more than others. Learners in rural settings and learners from low SES seem to be the most vulnerable. Worse than their urban counterparts, rural learners go through the basic education without achieving nearly half of the expected outcomes. The finding that there was a significant proportion of grade 6 learners who could only demonstrate competencies that are at a grade 3 level has serious implications.

Besides the obvious losses that government incurs as the key provider of basic education, learners miss a life opportunity. Not only will they find it difficult to cope in a highly competitive technological world, but the country may be caught up in a vicious cycle where parents of tomorrow will not be able to support their children to study mathematics because of fear that they may also not succeed. But this may also serve to deepen inequalities in society as well as in the world of employment.

Whilst the adoption of an outcomes-based curriculum is commendable, it would appear that there are challenges that, if not confronted directly, could compromise effective implementation. In particular, the quality of mathematics textbooks seemed not to be supportive of the ideals of the curriculum.   Textbooks were still steeped in content, reflected images that learners may not associate with and did not provide credible role models from learners' own societies. This may create distorted perceptions about the subject and diminish interest in learning mathematics.

One way of meeting the challenge would be empowering teachers to develop appropriate learner support material and not depend on textbooks. Materials developed at school level will meet the criteria of relevance and user-friendliness. Building the capacity of teachers as mediators of the curriculum may be the ultimate answer.

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Table 1: SACMEQ levels of competency mapped against South African school grades

#	SACMEQ level	School grade
1	Pre-numeracy	2 and lower
2	Emergent numeracy	3
3	Basic numeracy	4
4	Beginning numeracy	5
5	Competent numeracy	6
6	Mathematically-skilled	7
7	Concrete problem-solving	7+
8	Abstract problem-solving	7++

Table 2: Analysis of three mathematics texts used in South African schools

Text	Language of text	No. of text pages	% pages with at least one pictorial	% pages reflecting mathematics in society	% pages reflecting at least one local life example	Glossary of new words
Book A	English	226	46,9	27,8	3,1	X
Book B	English	161	65,2	48,5	3,1	X
Book C	English	140	27,1	9,3	2,1	√

Table 3. Percentages and sampling errors for numeracy levels of pupils by sub-groups

Sub-groups	Percentage of pupils reaching the mathematics competence level															
	1		**2**		**3**		**4**		**5**		**6**		**7**		**8**	
	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
Socio-economic level																
Low SES	10.7	1.14	54.9	2.04	25.5	1.54	6.0	1.09	1.7	0.63	1.1	0.63	0.1	0.09	0.0	0.04
High SES	5.0	0.73	34.2	3.22	22.1	2.19	11.5	1.40	10.3	2.34	10.3	1.66	4.0	0.88	2.5	0.92
School location																
Isolated/rural	11.8	1.48	59.6	2.08	22.7	1.70	4.6	1.09	1.0	0.49	0.3	0.15	0.1	0.10	0.0	0.00
Small town	7.7	1.35	46.9	3.87	27.5	2.17	9.8	1.98	4.0	1.62	2.3	0.90	1.4	0.65	0.4	0.30
Large city	2.4	0.75	20.0	4.21	21.1	3.22	14.2	2.01	15.5	4.04	17.1	2.71	5.7	1.55	4.0	1.60
South Africa	7.8	0.77	44.4	2.32	23.8	1.37	8.8	0.96	6.1	1.47	5.8	1.09	2.1	0.46	1.3	0.48

Figure 1: Percentage of learners by SACMEQ levels in mathematics

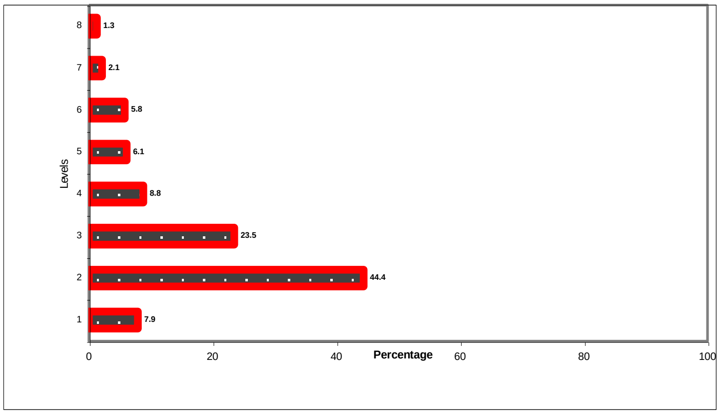

Figure 2: **Percentage of learners by SACMEQ levels and school location**

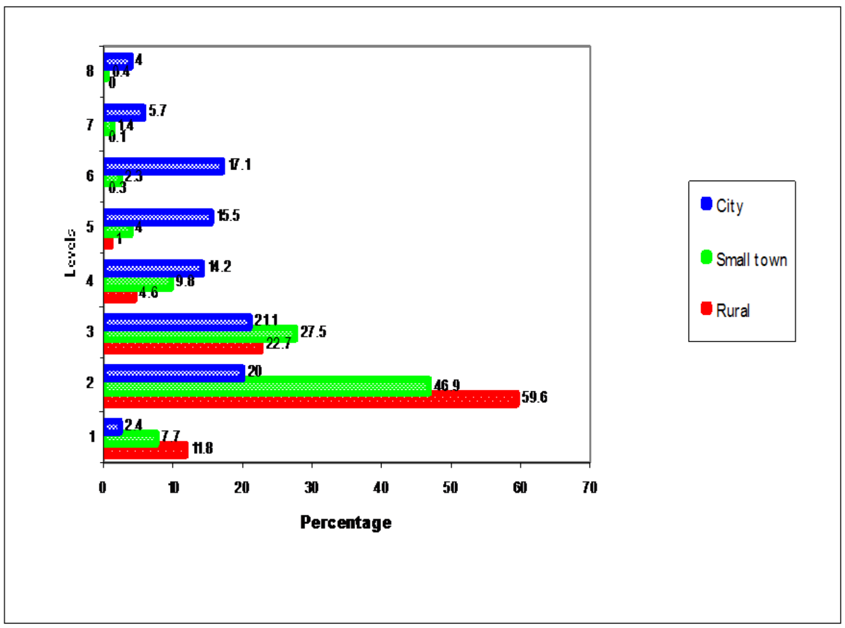

Figure 3: **Percentage of learners by SACMEQ levels and socio-economic status**