Mathematics Registers in Indigenous Languages: Experiences from South Africa

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Through reporting on an initiative in South Africa that aimed to provide epistemological access to teachers and learners of mathematics (and science) through translating mathematical concepts into two indigenous languages, this paper argues for the urgent development of mathematical registers in indigenous languages for mathematics and science. The pilot research reported on in this paper indicates that the use of a multilingual concept literacy book impacted noticeably on the code-switching practices of selected teachers who switched between English and Xhosa in their teaching of mathematics.

It goes without saying that the understanding of key concepts in mathematics and science is fundamental to the teaching and learning of these disciplines. Research confirms that one of the key dimensions to understanding concepts is language. The intimate relationship between language and the understanding of concepts is well documented. For example, the poor performance of South African learners in the 1995 and 1999 Trends in International Mathematics and Science Study (TIMSS) is largely ascribed to the problem that learners and teachers have in studying and teaching through English as a second or even third language.

To address this problem a multilingual learning and teaching resource and support book (Grade 9 – 10 levels) was developed at the Centre for Applied Language and Literacy Studies and Services in Africa (CALLSSA) at the University of Cape Town in collaboration with Rhodes University and the University of KwaZulu Natal. The book provides detailed meanings and explanations for key mathematics and science concepts in Zulu, Xhosa, Afrikaans, and English. It is argued that when learners and teachers have access to these concepts in their own languages, they can transfer such understanding to their dealing with English as the language of learning and teaching (LoLT). The book was validated through a collaborative process involving the three universities. The validation process was enhanced by a research process of trialling and evaluating the book with practicing teachers in their classroom setting. This *inter alia* included an investigation of:

1. the accuracy of the concept explanations in the four languages used;
2. the appropriateness of the translations;
3. the general effectiveness of the book as a learning and teaching resource.

The research involved the participation of Grade 10 teachers in the Western Cape, Eastern Cape, and KwaZulu Natal of South Africa. This paper aims to share some of the experiences encountered in the development of this book by briefly describing the development process and the content of the resource book, and also highlighting some of the research issues that were encountered with special reference to code-switching practices as a central pedagogical strategy in many South African classrooms. Against the backdrop of each South African child's constitutional right to be taught in the language of his/her choice, this paper argues for the urgent development of mathematics (and science) registers in indigenous languages.

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Concept Literacy – a Brief Theoretical Discussion

The problem of language proficiency as an obstacle to learning mathematics and science is well documented (Adler, 2001; Howie, 2002; Setati, 2005). Young, van der Vlugt and Qanya (2004) suggest that this problem can be addressed at two inter-related levels: (a) concept understanding and use, and (b) language/discourse contexts and forms in which these concepts are embedded.

The notion of *concept literacy* that framed the development of the multilingual resource book can be described as "understanding, through reading, writing and appropriate use, basic learning-area specific terms and concepts in their language contexts" (Young et al., 2004). Kilpatrick, Swafford and Findell (2001), describe conceptual understanding as a critical component of mathematical proficiency that is necessary for anyone to learn mathematics successfully. Conceptual understanding implies an understanding of knowledge that not only revolves around isolated facts but includes an understanding of the different contexts that frame and inform these facts. Kilpatrick et al. (2001) suggest that, "students with conceptual understanding … have organized their knowledge into a coherent whole, which enables them to learn new ideas by connecting those ideas to what they already know" (p. 118). The framework of interwoven strands of mathematical proficiency in Kilpatrick's model identifies conceptual understanding as one of the strands that is essential to the development of understanding mathematical concepts, operations, and relations.

But what is a concept? The idea of a concept is controversial and difficult to define. It ranges from a personal idea or construct to a statement that is universal and generic. The definition that underpins the development of the multilingual resource book under scrutiny, suggests that a concept is a "mental picture which has a standard and universally accepted meaning" (Young et al., 2004). Similarly, the notion of literacy is difficult to pin down as it no longer simply refers to the ability to read and write. Young et al. (2004) argue that literacy implies a capacity to recognise, reproduce and manipulate the conventions of text, spoken and written, shared by a given community. Concept literacy therefore emphasises the interaction between context and content. It is a process that is dynamic and that changes over time as the concept is internalised and understood. From a Vygotskian and constructivist perspective this implies that concept literacy involves the modification of prior conceptions and experience. Fundamental to this process is of course language proficiency. Young et al. (2004) correctly argue that it is therefore likely that modifying one's prior knowledge if one is learning in an additional language (a language other than the first language) can be problematic, particularly if one is not proficient in that additional language.

Although Kilpatrick et al. (2001) suggested that conceptual understanding "need not be explicit" (p. 118), it is asserted that verbalisation, and thus language, is a key factor in conceptual understanding. Language and conceptual understanding are inseparable. It is thus important that for effective teaching of mathematical concepts to happen, a shared mathematical register should exist in the language of instruction. In most multilingual communities in Africa, such as South Africa, this is not the case.

For most South African teachers and students of mathematics and science, the LoLT in these disciplines is English – an additional language that for many is difficult to understand and use. To address these difficulties CALLSSA embarked on developing and writing a learning and teaching resource and support book for Mathematics and Science. This book provides detailed meanings and explanations for key concepts in Xhosa, Zulu, Afrikaans and English within the framework of the Revised National Curriculum Statement (RNCS)

at a Grade 9 – 10 levels. It lists about 60 key RNCS mathematics and science concepts that are grouped under the themes of time, space, and number for mathematics, and energy, matter, earth, and life for science. Very importantly, attention is also given to the everyday English meanings of these specific concepts. As Young et al. (2005) note, the words and language forms of mathematics and science often differ markedly from those of everyday use of the same words. For example, concepts like power, force, revolution, work, and pressure have very different everyday meanings to their specialised meanings in mathematics and sciences.

The development of the book was a collaborative process with teachers of mathematics and science in the Western Cape, Eastern Cape, and KwaZulu Natal, and validated by expertise in mathematics and science education, Xhosa, Zulu, and Afrikaans from across South Africa. In its introduction the book acknowledges some of the dilemmas that were faced in the translation and explanation of concepts:

> We are very aware of questions about which Xhosa or Zulu words or terms for these concepts are 'correct', standardised forms. We have, wherever possible, tried to ensure that our uses of both Xhosa and Zulu are correct. Until these two languages, and other African languages, are fully standardised, our text must serve as an interim attempt to offer translation equivalents in Xhosa and Zulu for English concepts dealt with in this book. We think it is better to present work close to the ideal as a starting point rather than to have nothing available! (Young, D., van der Vlugt, J., & Qanya, S., 2005, p. vii).

Teachers from across the three provinces participated in the development phases of the book by trialing sections of the initial manuscript and providing feedback on their experiences. Lessons were videotaped and deconstructed with the participating teachers. Issues such as inaccuracies in translations and the use of inappropriate and inaccessible diagrams were identified and noted. These were then incorporated in the final version of the book. The book was marketed in all the provincial education departments of South Africa, and those provinces where Xhosa and Zulu are particularly prevalent have ordered copies for their teachers.

Code-switching and Some Tentative Research Results

South Africa is a multicultural and multilingual country with a diversity of 11 official languages. Although the Language-in-Education Policy insists that the LoLT in the first four years of schooling is mother-tongue, the use of code-switching is common practice in most schools where the home language of teachers and learners is not English. In South Africa these are mostly schools that, in the apartheid years, were classified as black or township schools. Code-switching is the practice where "an individual (more or less deliberately) alternates between two or more languages" (Baker, 1993, pp. 76–77). As Setati notes, code-switching "can be between languages, registers and discourses" (2005, p. 91). In the South African classroom, code-switching would typically involve an indigenous language and English. Despite policy that states that the medium of instruction changes to English after Grade 4, the practice of code-switching is often sustained for the entire duration of schooling. It is argued that code-switching can be a powerful and effective pedagogical tool to overcome language barriers to teaching and learning. As Setati and Adler (2001) noticed, many teachers in South Africa have a dual task of teaching both mathematics and English at the same time. It goes without saying that by the same token learners also have to cope with the language of mathematics and the language in which it is taught – and this in many instances is a second or even third language.

Recent preliminary pilot research in the Eastern Cape by Thokwe and Schäfer (2009) explored how the Concept Literacy book in question impacted particularly on the code-switching practices of selected Xhosa-speaking Grade 10 mathematics teachers. Four teachers with similar code-switching practices were involved in the pilot study. The code-switching practices of two of the teachers were observed and documented over a number of lessons before they were introduced to the Concept Literacy book. Their use of the two languages (English and Xhosa) was recorded over a period of time and is illustrated in Figure 1, which shows a combined analysis of their code-switching practices.

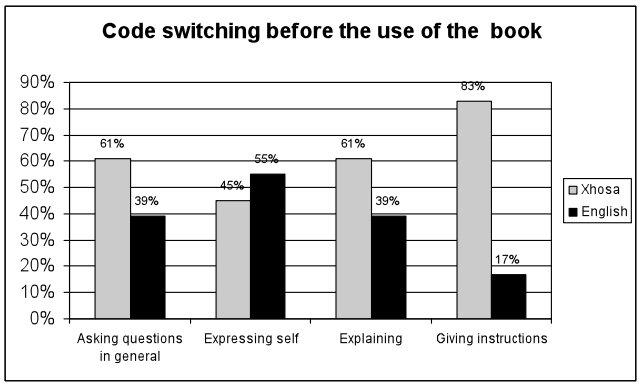

Figure 1. Code-switching practices of two teachers before the use of the Concept Literacy book.

It is interesting to note that when giving instructions, both teachers preferred to use the vernacular. This trend however changed when the teachers started to explain and illustrate mathematical concepts and terms. The use of English became more prominent and the practice of code-switching increased. This is illustrated in the following conversation:

> **Consider the situation whereby** *siza kuthatha ii* **triangles** *zethu ezimbini sizibeke* **on top of one another**. **What I'm trying to say is this** [drawing 2 triangles adjacent to each other]. Translation: **Consider the situation whereby** *we will be taking our two* **triangles** *and put them* **on top of one another**. **What I'm trying to say is this** *[drawing 2 triangles adjacent to each other]*
>
> **If you say now all angles of a triangle are equal**, *ingaba i* **angle** *inye kuzo* errr *ndicinga ukuba…….. Ingaba inye iza kuba* **how many**? (Teacher and learners respond simultaneously.) "*Ngu* 60 **degrees**." Translation: **If you say now all angles of a triangle are equal**, *is it that one of the* **angles** *err.. I think that……. How many will one of them? (Teacher and learners respond simultaneously.) "It is 60* **degrees.***"*
>
> **"In other words**, *ukuba siza kuthi le yi* **parallelogram**, **so that means** *eli cala lingapha liza kuba* **parallel** *kwela cala lingaphaya* **and** *eli lona libe* **parallel** *kweli lingaphaya."* Translation: "**In other words**, *if we say that this a* **parallelogram**, **so that means** *this side here will be* **parallel** *to that side on the other side* **and** *this one will be* **parallel** *to the one on the other side.*

The above scenario is, however, not surprising if one considers the lack of a mathematical register in Xhosa and the dearth of mathematical resources and texts in that language. There are many constraints in mother-tongue education. As Probyn (2002) stated, "… there are [numerous] linguistic and economic constraints on mother-tongue education: the fact that indigenous languages have not been used for academic purposes means that the necessary terminology and textbook resources have not been developed" (p. 10).

After using the book over a period of two terms, the code-switching practice of two teachers was once again observed and documented. This is illustrated in Figure 2, which shows a combined analysis of their code-switching practices over a period of time.

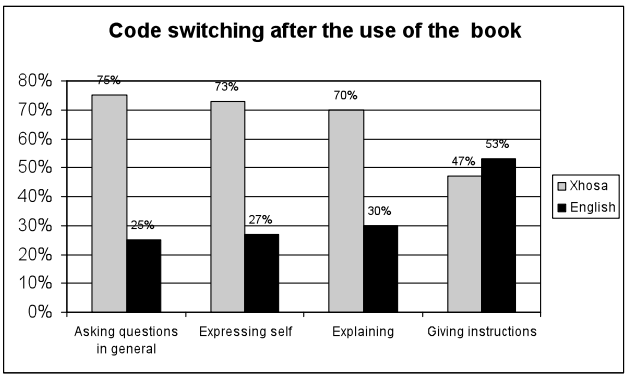

Figure 2. Code-switching practices of two teachers after the use of the Concept Literacy book.

It is interesting to observe that after the Concept Literacy Resource book intervention the use of Xhosa increased markedly for the following categories of communication: asking questions, expressing self, and explaining. Notwithstanding the small sample and the tentative nature of the pilot, this suggests that the Concept Literacy Resource book had an impact on the code-switching practices of the participating teachers. Their use of their first language increased and they appeared more confident in using Xhosa in mediating mathematical concepts.

In general, the Concept Literacy Resource Book was well received and initial classroom visitations revealed the following:

1. *Deep Xhosa versus everyday Xhosa.* A number of the teachers felt that the Xhosa that was used in the resource book was at times difficult to understand. They felt that the translations were dominated by 'deep' Xhosa – sometimes also referred to as rural, old, traditional, or formal Xhosa as opposed to 'township' Xhosa – also referred to as everyday or modern Xhosa. According to the teachers, many of the learners expressed similar sentiments.
2. *Inconsistent use of Xhosa*. In some instances it was felt that the translation used in the text was not consistent with some of the dictionaries to which the teachers had access (Schäfer, 2005).
3. *Assistance in conceptualisation*. A number of teachers said that the Xhosa text assisted in their own conceptualisation of a particular concept. This also applied to many of the learners who were provided with photocopies of the text in various lessons (Schäfer, 2005).
4. *More comprehensive translation*. There was widespread consensus that the entire book needed to be translated into Xhosa and not just the key concepts (Schäfer, 2005).
5. *Texts in mother-tongue*. Many of the teachers felt that they themselves were not aware of the existence of some of the Xhosa terminology and were surprised when they encountered some of the terms in their own language. There was consensus that a standardised Xhosa mathematical register needed to be developed as soon as possible. There was a strong commitment from the teachers to the preservation of Xhosa and many felt that it was important to teach through the medium of Xhosa.

It was, however, also recognised that in an era of globalisation and market-driven economies, the dominance and power of English cannot be ignored (Schäfer, 2005).

6. *Resistance to Xhosa*. There was resistance to the use of Xhosa by some learners. They felt that English was the international and dominant language and hence they needed to learn mathematics and science in that language. Incidentally, numerous teachers commented that a similar sentiment existed amongst some parents who felt that teaching should be done through the medium of English and not through the mother-tongue (Schäfer, 2005).
7. *Support of textbooks and other learning areas*. The resource book was used to support the textbook in lesson preparation and implementation. Some teachers photocopied pages out of the book to hand to the class (Schäfer, 2005).

Conclusion

Our research into the use of the Concept Literacy Resource book shows that a multilingual text of this nature is long overdue and could play an important role in enhancing the role of indigenous language in the teaching and learning of mathematics in South Africa. The development of a mathematics and science register in all indigenous languages is fundamental to the realisation of the vision that asserts that each child should have the choice of his/her language of instruction.

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