

# TEACHER CODE SWITCHING: A CALL FOR THE DEVELOPMENT OF MATHEMATICS REGISTERS IN INDIGENOUS LANGUAGES

Clemence Chikiwa  
Department of Education  
Rhodes University  
South Africa  
Email: [c.chikiwa@ru.ac.za](mailto:c.chikiwa@ru.ac.za)

Marc Schafer  
Department of Education  
Rhodes University  
South Africa  
Email: [m.schafer@ru.ac.za](mailto:m.schafer@ru.ac.za)

**Abstract**–The teaching of Mathematics using English as the Language of Learning and Teaching (LOLT) to students whose first language is not English has and still is posing challenges to teachers. This has resulted in teacher code switching into indigenous languages in an effort to enhance conceptual understanding and access to a Mathematics register. This paper investigated code switching practices of three IsiXhosa first language speaking Mathematics teachers focusing on consistency and precision in the use of IsiXhosa during teaching. Results indicated that the amount of teacher code switching was not consistent across teachers and categories. Teachers were found to operate consistently in the public domain or everyday mode of talking, but not so within the esoteric mode. Very little transparent code switching which supports students’ understanding and thinking in mathematics, was evident in teacher language. Teachers were consistent in the use of borrowed terms.

**Keywords:** Code Switching, Mathematics Register, Language

## 1. INTRODUCTION

Mathematics teaching and the language of learning and teaching (LOLT) is a debatable issue in the South African education system. The continual search for strategies that will enhance the increased conceptual teaching and learning of Mathematics is paramount amid calls from concerned parties for immediate and long lasting solutions to the quality teaching of the subject.

This paper draws from literature and preliminary results of a study that is ongoing in three South African Eastern Cape multilingual mathematics classes. This ongoing study focuses on the code switching consistency and precision in teachers’ oral language production during teaching at secondary school level. Code switching, defined by Adler (2001) as the use of more than one language in the same conversation, is now widely accepted and viewed as a legitimate resource for supporting teaching and learning in multilingual classes (Setati, 2008). This results in the following questions: How precise and consistent is the teacher’s code switching with respect to the English mathematics register (language of learning and teaching, LOLT)? With code switching widely practised in classrooms and recognised as a legitimate teaching and learning resource, what are the best practises for code switching in a multilingual Mathematics classroom in South Africa? Should the development of a mathematics register in indigenous languages of South Africa be pursued?

## 2. THE MATHEMATICS REGISTER

Haliday (1978: 195) defines a register as “a set of meanings that are appropriate to a particular function of language, together with the words and structures which expresses these meanings”. Words and phrases in Mathematics thus, assume specific meanings appropriate to the subject. The mathematics register, therefore, refers to “the way of using symbols, specialist vocabulary, precision in expression, grammatical structures, formality and impersonality that results in ways of expression that are recognisably mathematical” (Lee: 2006, 14). The mathematics register thus employs language that may be used in everyday life, for mathematical purposes and in expressing mathematical meanings.

Key features of a mathematics register based on the works of Lemke (2003), O’ Halloran (2000), and Schleppegrell (2007, 2012) can be divided into two major groups; multiple semiotic register comprising of mathematics symbolic notations, oral language, written language, and graphical and

visual displays; and grammatical patterns involving technical vocabulary, dense noun phrases, being and having verbs, conjunctions with technical meanings and implicit logical relationships. Our particular study is interested in the grammatical patterns and oral language of the multiple semiotic register. Schleppegrell (2007) and Meaney, Trinick & Fairhall (2012) further divided oral language into technical terms (words with meanings only in a mathematical discourse), lexical words (specialist use of more general terms) and everyday words (mathematics terms that use everyday words for unrelated ideas, for example, expression, function, difference).

In all the cases cited above, the presence of a technical (specialised or formal) register and the everyday (non-specialised or informal) register is reiterated. A key challenge thus exists in the teaching of Mathematics where students are to be assisted in moving from every day, informal ways of construing knowledge into specialised, esoteric and academic ways that leads to real mathematical learning and understanding. A key frame of reference in our study is that “if mathematics concepts are not introduced and explained in oral language that moves from ordinary language that students already understand, to the more technical language that they need to develop for full understanding of the concepts (and for disciplinary learning of Mathematics), student learning suffers” (Schleppegrell, 2007, 156). The case is unique and complex for English second language speakers, because they are learning the ordinary English and also use their home language which in many cases is in the form of ordinary, non-specialised language. Thus bridging the gap between conversational language and official mathematics language is not a straight forward matter and requires teachers to be more innovative than simply relying on oral discussion as a vehicle for teaching and learning (Meaney et al, 2012). Questions are then raised whether it is desirable to support the development of mathematics registers in indigenous languages in order to bridge the gap between teachers’ spoken language and formal classroom mathematics language.

Teachers can facilitate and enable pupils’ understanding of complex and abstract mathematical content if they use the mathematics register effectively (Schleppegrell, 2007) through the deliberate move from every day to technical use, from ordinary non-specialised forms to formal, specialised and esoteric modes of talking (Dowling, 2010). What then, are the forms of support that teachers need in order for such beneficial teacher language behaviour to become a reality in South African schools? While the prevalent use of code switching in South Africa’s classrooms is widely documented (Setati 2005, 2008; Probyn, 2009, Schafer, 2010) its ad hoc use in order to explain English terms and concepts was found to be a source of learners’ misconceptions regarding scientific concepts (Sanders, 1993). This is because some mathematical terms chosen by the teacher are under-differentiated in indigenous languages in relation to their English equivalents.

### **3. SOME INITIATIVES IN SOUTH AFRICA**

In the South African Education system, there have been numerous projects that were embarked on in an effort to address the challenges caused by language in the teaching of Mathematics. As noted by Wildsmith-Cromarty (2012; 158), “the call for applied linguists and educationists to be more ‘socially responsible’ has been responded to by a number of initiatives in South Africa, particularly in the area of language in education”.

One of such initiatives is the development and publication of Mathematics dictionaries which are available for schools to buy and use for teaching and learning. The Department of Arts and Culture, (DAC) (2003), published a dictionary for multilingual foundation phase (FP) and intermediate phase (IP) Mathematics classrooms in the eleven official languages of South Africa. This dictionary provides a glossary of Mathematics terms for Grade R-6 with definitions or explanations. A recent edition of this dictionary, the Mathematics Multilingual Dictionary (2013; xii) explains that “the aim of this list is to make a contribution towards mother tongue education for all speech communities in South Africa and it therefore does not include complex mathematics terminologies”.

The Longman Multilingual Mathematics dictionary for South African schools (2008) published in English, IsiXhosa and Afrikaans has explanations, illustrations and diagrams of concepts identified. The Cambridge University Press (2010) IsiXhosa Mathematics dictionary for Grades 4-9 has concepts

written in English first, and then the IsiXhosa translation, with definitions and explanations of the concept in IsiXhosa only.

All the dictionary initiatives cited above are meant for Grade R – 9 and caters to a lesser extent for the Further Education and Training (FET) phase. The Concept Literacy Project (CLP), an initiative that originated at the University of Cape Town and eventually expanded to Rhodes University (Eastern Cape) and University of KwaZulu-Natal (KwaZulu-Natal), resulted in the development of two resource books:- ‘Understanding Concepts in Mathematics and Science’ by Young et al, Volume 1 (2005) and Volume 2 (2009). As commented by Schafer (2010), these support materials provide detailed meanings and explanations for the key Mathematics and Science concepts in two indigenous languages (Xhosa and Zulu) and in English and Afrikaans. These resource books are meant to provide home language support for the learning and teaching of Science and Mathematics at FET and GET levels. Wildsmith-Cromarty (2012) emphasised that these books are not designed to replace the key or prescribed Mathematics and Science textbooks in the classroom but rather to supplement and support teaching activities carried out predominantly in English with regular teacher code switching into indigenous languages. Volume 1 published in 2005 has 56 core Mathematics concepts that are covered in the GET (Grades 4-9) syllabus, while volume 2 published in 2009 has 68 core Mathematics concepts that extends up to FET level.

One of the findings that emanated from the use of this book as observed by Wildsmith-Cromarty (2012) revealed that the availability of translations in the African language tended to enhance the use of code switching for explanatory purposes. Schafer (2010) also observed that the use of this book increased markedly the use of IsiXhosa in asking questions, explaining concepts and expressing oneself. He concluded that the teachers’ use of the resource book led to their increased first language use and they appeared to be more confident in using IsiXhosa in mediating Mathematics concepts.

In the literature, apart from the CLP, there appears to be limited published multilingual materials available for use that provides mathematical terminology and explanations in indigenous languages meeting the needs of FET multilingual classroom teachers and students in South Africa.

#### **4. THEORETICAL FRAMEWORK**

This study is informed by aspects of socio-cultural theory as envisaged by Vygotsky, particularly the critical role of language in communication and cognitive development. Vygotsky’s theory emphasizes the social environment as a facilitator of development and learning (Tudge & Scrimsher, 2003). By embracing a socio-cultural perspective it is possible to view the language backgrounds of the teachers and pupils as a resource for teaching and learning Mathematics (Moschkovich, 2007). The socio-cultural aspects of Vygotsky’s theory illuminate the point that learning and development cannot be dissociated from their context. The social environment influences cognition through its “tools” i.e. cultural objects, language, and social institutions. According to Vygotsky (1978), people use psychological tools- signs, symbols and conventions that have been socially negotiated- to engage and understand their environments. People think and perceive things in a way made possible by the vocabulary and phraseology of their language, hence, concepts that cannot be encoded in their language will not be accessible to them, or at least will prove very difficult (Durkin, 1991). Learning then is seen as internalization which is the transformation of communicative language into inner speech and further into verbal thinking (Vygotsky, 1978).

Orton (2004) emphasizes that language used for thinking is almost certainly the first language. Thus Mathematics communicated in one language might need to be translated into another to allow thinking and then translated back in order to converse with the teacher. Vygotsky thus, perceptively observed that language forms do not replace one another but coexist in the human mind (Oakley, 2004). Vygotsky’s theory helps frame issues of learners’ first languages as used by the teachers explored in this study, as they relate to code switching in the Mathematics multilingual classroom.

## 5. SAMPLE AND RESEARCH PROCESS

Three grade 11 Mathematics teachers were purposefully selected from three secondary schools in the Eastern Cape Province. Each teacher was observed for five consecutive lessons in a week teaching trigonometry. The lessons were video recorded. At the end of each lesson, each teacher was interviewed following up on the lesson that the teacher has just taught.

The videos were transcribed and analysed in terms of:

- a) consistency in the frequency of code switching into IsiXhosa across teachers, and
- b) lesson categories developed from the works of Gumperz (1982) and Mercer (1995).

The lesson categories for b) are:

- response to student contribution (RC),
- questioning (TQ),
- teacher explanation (TE),
- classroom assessment techniques (CA),
- evaluative remarks (ER), and
- class management talk (CM).

Further, the data was analysed for consistency and precision across mathematical domains of practice as propounded by Dowling (1998). These domains are:

- Esoteric domain, which is characterised by the use of highly specialized, formal and abstract mathematical language and content;
- Descriptive domain, which uses specialized mathematical language imposed on non-mathematical content;
- Expressive domain, which deploys non-mathematical language to refer to mathematical content;
- Public domain, which is characterised by referring to forms of expressions and content expressed in entirely everyday terms.

Two overall teacher code switching practises emerged. These were referred to as borrowed code switching (BCS) and transparent code switching (TCS). Data was further analysed for consistency in these two practices.

### 5.1. Borrowed Code Switching Strategies (BCS)

BCS is where a teacher borrows from the English language either by retaining the English spelling or by adapting the phonology of the borrowing language (Baker, 2011) in this case IsiXhosa. Two forms of borrowing code switching were noted:

Transliteration (TLT), where nativisation of existing English language mathematical terms (Begg, 1991) was done. This involved giving an IsiXhosa spelling and pronunciation to English terms (Barton, Fairhall and Trinick, 1995); and

Loan word borrowing (LWB), where teachers borrowed from the English language, retaining the spelling, meaning and pronunciation of the word (Baker, 2011).

### 5.2. Transparent Code Switching Strategies (TCS)

TCS is where the meaning of the terms was not concealed but noticeable, self-evident and transparent to students (Meaney et al, 2012). Four forms of TCS as adapted from Gauton et al, (2003) emerged in this study;

- Semantic Transfer (SST)-Code switching where a new meaning, and/ or additional more technical meaning, was attached to existing words by modifying their semantic content.
- Paraphrase (PAR) - Code switching that was a short description or explanation of the word derived by putting together related words or unrelated words (Baker, 2011).

- Compounding (COM) - Code switching where a term was coined by combining existing words to form one word (Meaney et al, 2012).
- Ready Translated Equivalent (RTE)- this refers to all situations where there was no problem of non-equivalence at word and/or phrase level between source (English) and target language (IsiXhosa) because IsiXhosa already possessed ready equivalent of the English term (Gauton et al, 2003).

### 5.3 Validity

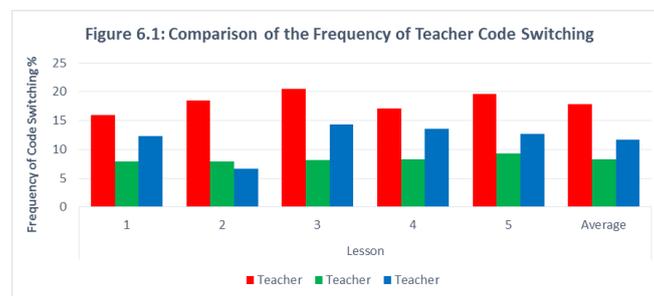
Validity is defined as the degree to which data collected in the research truly measures that which it was intended to measure (Creswell, 2009) or how truthful the research results are. Multiple sources of evidence were used during data collection thereby increasing the validity of the data in this study. As argued by Yin (2003, p99), “case study design proposes using multiple sources of evidence in a triangulation fusion to contribute to addressing any potential problems.” Three methods of data gathering (lesson observation, document analysis and semi-structured interviews) were used in our study that. Data triangulation, that is, the analysis of qualitative data received from semi-structured interviews and quantitative data from lesson observations and document analysis, was also done. The process of triangulation was intended to add value to the validity of this study as themes were established based on several sources of data.

## 6. RESULTS AND DISCUSSION

For the purposes of this paper, we will only be discussing the following:

- General frequency of teacher code switching
- Teacher code switching frequency per lesson category
- Code switching across domains of mathematical practice
- Emerging code switching practices

### 6.1. General Frequency of Teacher Code Switching



**Figure 6.1: Comparison of the Frequency of Teacher Code Switching**

As can be seen in Figure 6.1, teacher A code switched into IsiXhosa more than the other two teachers and was fairly consistent in this throughout the five lessons. On average teacher A conducted 18% of the classroom talking in IsiXhosa. Teacher B only did 9% of his classroom talk in IsiXhosa. Teacher C, whose amount of code switching gradually increased across the five lessons, code switched half as much as teacher A. Teacher C however, spent on average 12% of his talking in IsiXhosa and was inconsistent in the amount of code switching across lessons.

Across all teachers, the amount of code switching was found to be inconsistent. The three teachers exhibited different quantities of code switched terminology across lessons. All the teachers indicated during interviews that they did not plan in any form for code switching. It occurs spontaneously during teaching, they said. Teacher B said “In our daily conversations, we code switch without any planning and hence even in class it is the same”

## 6.2. Teacher Code Switching Frequency per Lesson Category

As indicated in Figure 6.2, in the teaching of Trigonometry, all teachers used IsiXhosa predominantly to ask questions-TQ- (A-31%, B- 40%, C-37%) and for the purpose of explaining concepts-TE- (A-45%, B-39%, C-42%). It is apparent that the consistency of the frequency of code switching into IsiXhosa across the teachers for TQ and TE respectively varies.

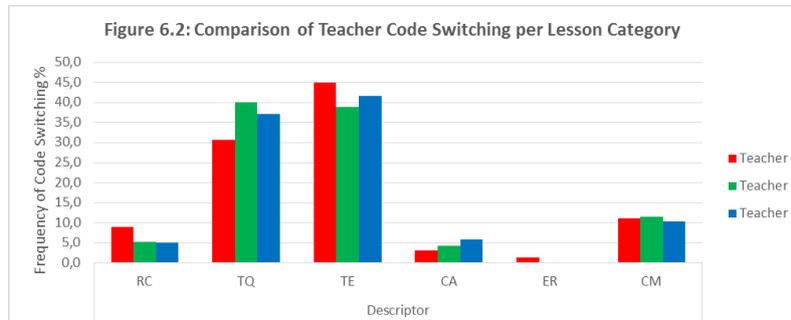


Figure 6.2: Comparison of Teacher Code Switching per Lesson Category

Interestingly, we observed that learners would make their contributions in IsiXhosa most of the time and teachers would respond and follow-up in English. During the interviews, teacher B indicated that he encourages students to respond in English and use it correctly. Teacher A said, “All our textbooks are in English, the school’s language for teaching is English and all our exams and tests that we give are in English. So it [responding in English] is to help the student” Evaluative remarks (ER) by the teachers were mostly done in English except in the case of Teacher C.

## 6.3 Code Switching Across Domains of Mathematical Practice

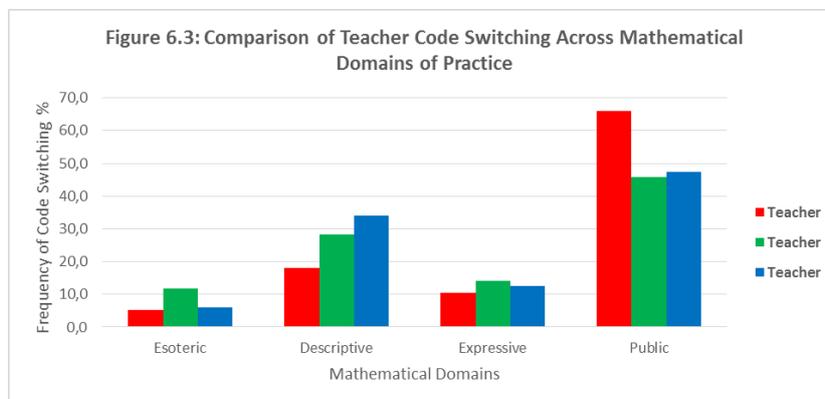


Figure 6.3: Comparison of Teacher Code Switching Across Mathematical Domains of Practice

Figure 6.3 illustrates the observation that all the participating teachers operated mostly in the public domain (A-66%, B-46%, C-47%). Very few of their IsiXhosa terms (A-5%, B-12%, C-6%) were in the esoteric domain.

Considering that most of the classroom code switching was done during questioning (TQ) and explaining (TE), and that all the three teachers operated mainly in the public domain, implies that teachers predominantly taught in the everyday domain. This, according to Dowling (1998, 2000), it can be argued that not much formal Mathematics is taught.

## 6.4. Document Collection and Analysis

Document collection and analysis revealed that only teacher A had access to some mathematical material in IsiXhosa even though she did not refer to it in her preparation for teaching. During the interviews, teacher A said she had the book by Young et al (2005) and (2009) but had never used it.

Teacher A stated that the terms used in the book were too deep for the students and unfamiliar. When teacher A was asked where she got her mathematical vocabulary in IsiXhosa, she said “It just comes when I am speaking, just like when we speak outside the classroom. I use common sense because we have some of these words in my language though not big ones like perpendicular or trigonometry”. Teacher A did not have lesson notes nor plans and used the textbook to select examples for classwork.

Teacher B had lesson notes in the form of a compilation of questions for classwork and homework, written in English. On being asked where and how he got his Xhosa vocabulary, the teacher said that “I rely on my own knowledge and understanding of Xhosa because it’s my mother tongue. I do not have any textbooks or dictionaries for Mathematics in IsiXhosa.”

Teacher C brought classwork on photocopies and PowerPoint slides. Teacher C had charts in his mathematics classroom on factorisation, functions, number systems and calculus. When asked where he got his vocabulary, he said “one has to be creative. I use my knowledge of Xhosa as it is my home language and I try to merge it with Mathematics. Some terms especially in this topic (trigonometry) are not there in my language.”

## 6.5. Data Analysis for Code Switching Strategies

### 6.5.1 Teacher A

Table 6.5.1

		LESSON					Total	
		1	2	3	4	5		
BCS	TLT	0.8	0.0	1.3	1.3	1.2	4.5	69.8
	LWB	19.2	3.5	17.7	13.4	11.5	65.3	
JCS	SST	1.9	0.3	2.2	0.5	0.6	5.5	30.2
	PAR	1.2	0.0	0.3	0.0	0.1	1.5	
	COM	0.3	0.0	1.8	0.4	0.4	2.8	
	RTE	7.4	1.4	3.8	4.5	3.2	20.4	
TOTAL		30.7	5.1	27.0	20.1	17.0	100.0	

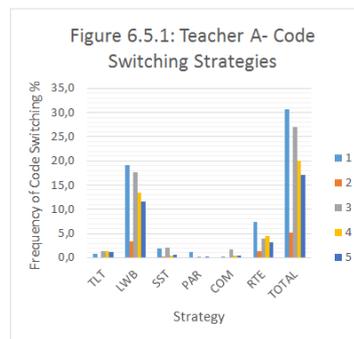


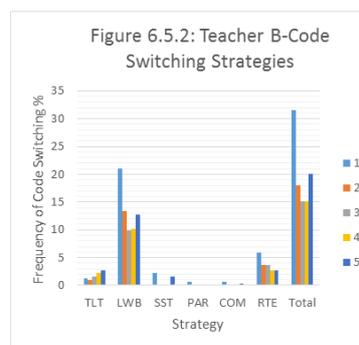
Table 6.5.1 shows that in all the five lessons, 65% of the mathematical terms in IsiXhosa used by teacher A in Trigonometry were obtained by loan word borrowing. The use of IsiXhosa mathematical terms varied across lessons 1 to 5 (30.7; 5.1; 27.0; 20.1; 17.0 respectively).

In summary, 69.8% of teacher A’s code switched mathematical terms were borrowed. 30.2% were code switched transparently.

### 6.5.2. Teacher B

Table 6.5.2

		LESSON					Total	
		1	2	3	4	5		
BCS	TLT	1.24	0.93	1.55	2.17	2.79	8.67	75.9
	LWB	21.1	13.3	9.91	10.2	12.7	67.2	
JCS	SST	2.17	0	0	0	1.55	3.72	24.1
	PAR	0.62	0	0	0	0	0.62	
	COM	0.62	0	0	0	0.31	0.93	
	RTE	5.88	3.72	3.72	2.79	2.79	18.9	
Total		31.6	18	15.2	15.2	20.1	100	



The use of mathematical terms by teacher B was fairly consistent across lessons as shown in Table 6.5.2. The LWB strategy (67.2%) occurred for most of the time. BCS accounted for 75% of the identified mathematical terms of teacher B, used during the teaching of trigonometry. 25% of the mathematical terms were through TCS. Teacher B consistently operated in the BCS strategy.

### 6.5.3 Teacher C

Table 6.5.3

		LESSON					Total	
		1	2	3	4	5		
BCS	TLT	4.8	1.3	1.1	0.4	3.1	10.8	78.7
	LWB	22.9	7.7	9.5	8.4	19.6	67.9	
TCS	SST	1.8	1.3	1.1	0.9	0.0	5.1	21.3
	PAR	0.0	0.0	0.2	0.0	0.2	0.4	
	COM	0.9	0.0	0.9	0.4	0.2	2.4	
	RTE	5.5	2.0	2.2	1.3	2.4	13.4	
Total		35.8	12.3	14.9	11.4	25.5	100.0	

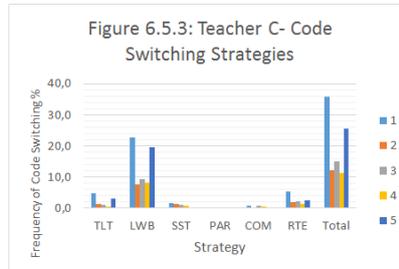
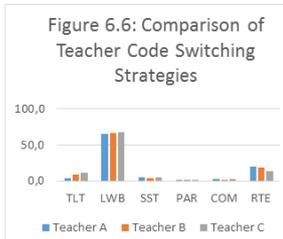


Table 6.5.3 shows that 79% of Teacher C's use of mathematical terms was through borrowing while only 21% was through TCS (see Table 6.5.3). For the transparent code switching strategy, RTE was employed 13.4% in the five lessons.

### 6.6. Comparison of Teacher Code Switching Strategies

Table 6.6

		Teacher A	Teacher B	Teacher C	Total
BCS	TLT	4.5	8.7	10.8	78.7
	LWB	65.3	67.2	67.9	
TCS	SST	5.5	3.7	5.1	21.3
	PAR	1.5	0.6	0.4	
	COM	2.8	0.9	2.4	
	RTE	20.4	18.9	13.4	



As is apparent from Table 6.6, teachers consistently used the LWB (A-65.3; B-67.2; C-67.9) strategy throughout the five lessons. The greater part of the mathematical talk in IsiXhosa was done through borrowing where teachers would attach prefixes to already existing English mathematical terms. All the teachers consistently used the borrowing strategy (A-69.8%; B-75.9%; C-88.7%) throughout the teaching of trigonometry, more than using the transparent code switching strategy (A-20.2%; B-24.1%; 11.3%). Teacher C borrowed 89% of mathematical terms from English and transparently code switched only 11% of the time.

Commonly noted borrowed terms were of the form *u-Sin*, *Kwi-triangle*, *i-perpendicular*, *i-height*, *ngu-Tan* and others. Teachers would also use a prefix on symbols and notation. Examples include *u-AB*, *ngo-AD* (meaning side AB), *u-C* (meaning angle C), *la-x* (x standing for a side), *sino-ABC* (we have), *ku-E*.

For all the teachers, most of their terms in the esoteric domain where code switched using the LWB and TLT. For example LWB- *i-height*, *Uyintoni u-angle C ku-AD?* (What is angle C in relation to AD?) *siyayibona ngantoni i-hypotenuse kanene?* (How do you identify the hypotenuse?)

TLT: *ufune i-ratio kengoku e-involved ne-hypotenuse* (find the ratio that involves the hypotenuse); *u-x wethu sim-provile uba u-x...* (We have proved that x...); *ubu solva la-C* (you were solving for C)

As illustrated in table 6.6, the presence of the RTE strategy in each of the teachers' mathematical terms (A-20.4%; B-18.9%; C-13.4%), was of interest to this study. The mathematical isiXhosa words that teachers used in day to day life and are mathematical, were categorised in this strategy.

The classroom use of RTE strategies suggests that there are mathematical words that exist in IsiXhosa. And because the teacher is using such terms in the classroom, means they are of the students' IsiXhosa dialect or they are familiar to these students. Interestingly, these RTE terms were commonly used by all the three teachers without reference to published mathematical sources in IsiXhosa. What may be required is to have these captured, collated and formalised. Examples of such terms used by the teachers included *fumana* (find), *bala* (calculate), *kuqala* (first), *zoba* (draw), *Krwela umgca* (draw a straight line), *dibanisa* (add), *cala* (side), *lingana* (equal to). These, according to teacher A, are used in daily life by the students and the teacher. These same terms/phrases have a technical or mathematical meaning. On checking the meaning of these terms, it was noted that they retain their mathematical meaning of their English equivalents.

Teacher C used connectives in IsiXhosa considerably more than others. These include; if (*noba*), or (*okanye*), of (*ka-*), that, if, so (*uba*), if (*xa*), that (*ubanangaba*), but (*qha*) among others. These had readily translated equivalence in IsiXhosa and hence were also categorised under RTE.

As Table 6.6 depicts, RTE, a transparent switching, was done at a very minimum level (A- 20.4%, B- 18.9%, C-13.4% of the total mathematical terms). Very little transparent code switching, which according to Meaney et al (2012), supports students' understanding and thinking in Mathematics, was evident in the observed teachers' language practices. Teaching strategies that will enhance the conceptual understanding of Mathematics and those that will aid thinking are key to achieving improvement in the teaching of the subject. The preliminary results suggest that, because most of the observed code switching practices are not transparent, the intended outcome of quality learning is compromised. Prevalent borrowed code switching, which apart from the added prefixes, are words in English does not provide learners with clues, hints or access to Mathematics concepts.

## 7. BEST PRACTICES FOR CODE SWITCHING

As code-switching is very prevalent in our schools and recognised as a legitimate teaching and learning resource, there is a pressing need to identify and document best practice. Although there is a scarcity of code switching materials in Mathematics, it is important that available code-switching support materials are utilised effectively. There is a huge need for the production of more and even better multilingual teaching resources in Mathematics. The complex and challenging nature of teaching Mathematics in multilingual classrooms makes the identification, production and use of materials for best instructional practices for code switching an urgent matter.

Considering that school mathematics texts are written in formal language, and code switching happens mainly in informal languages, there is an urgent need to reduce this gap. We argue that in order to introduce the formal Mathematical talk in indigenous languages, resulting in orienting students' oral language towards esoteric mathematical practices (Dowling, 1998), requires the development and use of mathematics registers in indigenous languages, in this case IsiXhosa. Mathematics teachers in multilingual classrooms need to be made aware of, and encouraged to use available multilingual mathematics resources to aid their teaching and learning of Mathematics.

Teachers in this study pointed out that they were trained to teach in English only because it is the LOLT. Essien (2013), a teacher trainer points out that teachers are trained in English and it is assumed that these same teachers will recontextualise what they have learnt in English into a different linguistic context at the end of their qualification. School teacher training institutions will need to be adequately resourced for this task. Essien (2010) noted that there are no structured courses that attend specifically to mathematics pre-service teachers of students who are not yet proficient in the language of instruction. The implementation of multilingualism in the classroom is left entirely for the teacher to decide as to the how, when and where to draw the mathematical vocabulary in indigenous language. Khisty (1995) cautions that knowing the mathematics register in

one language is not an obvious indication of knowing it another language. Deliberate steps will need to be taken to orient teachers to knowing mathematics register in another language that is to be used in the classroom. Wildsmith-Cromarty (2008) recommends that teacher training needs to be conducted in a bilingual institutional context to enable teachers to use indigenous languages for instructional purposes.

The issue of availability of resources in indigenous languages resonates with the idea of teacher preparedness for code switching. Best practices will thus imply proper prior planning for code switching in the classroom as opposed to impromptu, inconsistent and ad hoc code switching which is a current phenomenon in mathematics secondary school classrooms. Mgqwashu (2004) found that Tanzanian High School teachers using KiSwahili were not using KiSwahili technical terms, but non-technical register, and this did not give students access to the concepts and vocabulary needed for understanding the subject. Proper planning for code switching, where teachers refer to available multilingual resource for guidance, is regarded in this study, as important. We argue that this will lead to code switching that is beneficial to students. Such switching is as a result of the use of transparent terms in indigenous languages (Meaney et al, 2012) leading to code switching that is transparent.

A balance needs to be established between code switching and indigenous language terms that are familiar to students. Schafer (2010) reports that teachers who participated in the Concept Literacy Project and their students expressed concern over the 'deep' Xhosa also referred to as rural, old, traditional or formal, that was not familiar to both teachers and students. This paper argues for transparent code switching, where terms familiar to students are precisely and consistently used to give students access to mathematical concepts.

## 8. CONCLUSION

Teachers who participated in this study did not use any mathematical materials prepared in IsiXhosa. They relied on their own individual understanding and translations. Yet in those few instances they managed to code switch precisely and consistently with formal definitions of English Mathematics terms. With necessary support, through relevant and adequate teaching materials, teaching Mathematics for conceptual understanding can be enhanced. Development of teaching materials in IsiXhosa that will aid the teaching of Mathematics at GET and FET phases is crucial. This paper also concludes that initiatives on developing teaching materials in indigenous languages that have occurred and yielded results should be revisited, improved and made readily available and more accessible to teachers.

## REFERENCES

- Adler, J. (2001). Teaching Mathematics in multilingual classrooms. Dordrecht: Kluwer Academic Publisher.
- Baker, M. (2011). In Other Words. A Coursebook on Translation. 2nd Edition. London & New York: Routledge.
- Botes, H. & Mji, A. (2010). Language Diversity in the Mathematics Classroom: Does a Learner Companion make a Difference? South African Journal of Education 30:123 - 138.
- Creswell, J.M. (2009). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 3rd Edition. Los Angeles: Sage.
- Department of Arts and Culture. (2003). Multilingual Mathematics Dictionary: Grade R-6.
- Department of Arts and Culture. (2013). Multilingual Mathematics Dictionary: Grade R-6. 2nd Edition.
- Dowling, P. (1998). The sociology of mathematics education: mathematical myths/pedagogic texts. Falmer: London.
- Dowling, P. (2008). What is mathematics? The problem of recontextualisation. <http://homepage.mac.com/paulcdowling/ioe/publications/dowling2008b.pdf> (accessed 20 August, 2012).
- Dowling, P.C. (2010). 'Abandoning Mathematics and Hard Labour in Schools: A new sociology of knowledge and curriculum reform.' A paper presented at Madif 7, Stockholm, 27th January 2010.
- Durkin, K. (1991). Lexical ambiguity in Mathematical concepts. Language in Math Education. Milton Keynes: Open University press.
- Essein, A. (2010). Mathematics Teacher Educators' Account of Language(s) in Foundation Phase Mathematics Teacher Education. Preparing Pre-service Teachers for Teaching Mathematics in Multilingual Classrooms: The Case of South Africa. The International Journal of Interdisciplinary Social Sciences 5, 2: 33 - 44.
- Essein, A. (2013). Maths still best taught in English. Mail & Guardian, 02 Jun 2013.
- Gauton, R., Taljard, E. & De Schryver, G. (2003). Towards Strategies for Translating Terminology into all South African languages. A Corpus-based approach. Proceedings of the 6th International TAMA Conference. Pretoria (SF2) Press. Pp 81-88.
- Gumperz, J. (1982). Discourse Strategies. Cambridge: Cambridge University Press.
- Halliday, M. A. K. (1978). Language as social semiotic. London: Edward Arnold.

- Khisty, L. L. (1995). Making Inequality: Issues of Language & Meanings in Mathematics Teaching with Hispanic students; in W.G. Secanda, E. Fennema & L.B. Adajian (Eds.). *New directions for equity in Mathematics Education*, Cambridge University Press, Cambridge, pp 279-297.
- Lee, C. (2006). *Language for learning mathematics: Assessment for learning and practice*. New York; McGraw Hill house.
- Lemke, J. L. (2003). Mathematics in the middle: Measure, picture, gesture, sign, and word. In M. Anderson, A. S\_aenz-Ludlow, S. Zellweger, & V. V. Cifarelli (Eds.), *Linguistic Challenges of Mathematics* 157 Educational perspectives on mathematics as semiosis: From thinking to interpreting to knowing (pp. 215–234). Brooklyn, NY, and Ottawa, Ontario: Legas.
- Meaney, T., Trinick, T. & Fairhall, U. (2012). *Collaborating to Meet Language Challenges in Indigenous Mathematics Classrooms*. New York: Springer.
- Mercer, N. (1995) *The Guided Construction of Knowledge: talk amongst teachers and learners*. Clevedon: Multilingual Matters.
- Moschkovich, J. N. (2007). Examining mathematical Discourse practices, *For the Learning of Mathematics*, 27(1), 24-30.
- NCTM. (2010). Using two languages when learning Mathematics. How can research help us understand Mathematics learners who use two languages? National council of Teachers of Mathematics, 2010.
- Oakley, L. (2004). *Cognitive development*. London: Routledge.
- O'Halloran, K. L. (2000). Classroom discourse in mathematics: A multisemiotic analysis. *Linguistics and Education*, 10(3), 359–388.
- Orton, A. (2004). *Learning Math: Issues, theory and classroom practice*. 3rd edition. London; Continuum.
- Probyn, M. (2009). "Smuggling the vernacular into the classroom": Conflicts and tensions in classroom code-switching in township/rural schools in South Africa. *International Journal of Bilingual Education and Bilingualism*, 12, 123–136.
- Sanders, M. R. (1993). Erroneous ideas about Respiration: The Teacher Factor. *Journal of Research in Science Teaching*, 30(8), 919-934.
- Schäfer, M., (2010). Mathematics Registers in Indigenous Languages: Experiences from South Africa. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education: Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia*. Fremantle: MERGA
- Schleppegrell, M. J. (2007). The Linguistic Challenges of Mathematics Teaching and Learning: A Research Review. *Reading & Writing Quarterly*, 23: 139–159. Taylor & Francis Group.
- Schleppegrell, M. J. (2012). Academic Language in Teaching and Learning Introduction to the Special Issue. *The Elementary School Journal*, Vol. 112, No. 3, *Academic Language* (March 2012), pp. 409-418. The University of Chicago Press. <http://www.jstor.org/stable/10.1086/663297>. Accessed: 06/07/2012
- Setati, M. (2008). Access to Mathematics vs. access to the language of power: The Struggle in multilingual Mathematics classrooms. *South African Journal of Education*, 28, 103-116.
- Setati, M. (2005). Mathematics Education and Language policy research & practice in multilingual South Africa. In R. Vithal J. Adler & C. Keitel (Eds). *Math Education Research in South Africa: Perspectives, practices and possibilities*. HSRC. Pretoria.
- Tokwe, T. & Schafer, M. (2009). Investigating code-switching of English second language (ESL) teachers in the teaching of mathematics: A grade 9 and 10 case study. In: Schafer, M. & Macnamara, C. (Eds.) *Proceedings of the 17th Annual meeting of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE)*, Grahamstown.
- Tudge, J.R.H. & Scrimsher, S. (2003). Lev. S. Vygotsky on Education: A cultural-historical Interpersonal, and individual approach to development. In B.J. Zimmerman and D.H. Schunk (eds), *Educational Psychology: A Century of contributions*, p. 207-228. Mahwah, NJ: Erlbaum.
- Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological process*. Cambridge, MA: Harvard University Press.
- Wildsmith-Cromarty, R. (2012). Reflections on a research initiative aimed at enhancing the role of African languages in education in South Africa. *Journal for Language Teaching*, 46/2, pp 157- 170.
- Young, D., van der Vlugt, J., Qanya, S., Aldous, C., Anderson, T., Davies, N., Deyi, S., Diwu, C., Faragher, M., Hammond-Gordon, M., Mbatha, T., Mwepu, D., Nxasana, I., Rogan, J., Schäfer, M., Solomons, G., Stander, C., van Niekerk, M., Wildsmith-Cromarty, R. & Zuma, S. (2005). *Understanding Concepts in Mathematics and Science, Volume One: A Multilingual Learning and Teaching Resource Book in English, isiXhosa, isiZulu, Afrikaans*. Cape Town: Maskew Miller Longman.
- Young, D., van der Vlugt, J., Qanya, S., Abel, L., Brombacher, A., Clark, J., Donaldson, D., Johnston, P., Johnson, Y., Rijdsdijk, C., Schoeman, C. & Solomons, G. (2009). *Understanding Concepts in Mathematics and Science. Volume Two: A Multilingual Learning and Teaching Resource Book in English, isiXhosa, isiZulu, Afrikaans*. Cape Town: Maskew Miller Longman.