TEACHING MATHEMATICS IN THE PAPUA NEW GUINEA HIGHLANDS: A COMPLEX MULTILINGUAL CONTEXT

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The classrooms of Papua New Guinea are multilingual. For many years only the official language of education, English, was permitted for teaching. In the mid 1990s the curriculum changed to declare that multiple languages would be used in teaching in the first three years of schooling. In the next year English is introduced, and gradually over the next few years becomes the dominant language of teaching. This paper examines how eight teachers in the crucial transition year 3 use their multiple languages to teach mathematics, although they seem to use their other available languages to privilege English learning.

Introduction

Papua New Guinea (PNG) has the most languages per head of population in the world. With a population of about six and a half million people there are some 820 living distinct languages. Situated on the eastern half of the island of New Guinea, the people of tropical PNG live in many coastal villages through to villages in the deep valleys in the highlands that make travel from one valley to the next difficult at the best of times. Clearly the many languages spoken have always impacted on the education system. The first schools were founded by Christian missionaries in the late 1800s in coastal areas.

The highlands were so inaccessible that westerners thought they were largely uninhabited until they were reached by Australian 'explorers' in the early 1950s. In fact the majority of the population has always lived in the highlands. It was only then that the colonial Australian government began the extension of the school system into the high valleys. The missionaries had favoured the use of indigenous languages in schooling, with the better students who reached the later years of primary school being taught English.

With the coming of a whole country colonial policy in the late 1940s, an English only policy was imposed for teaching in all schools. The first author can remember sitting during his early years of school wondering what was going on, since he as a little boy never experienced the language of English until he went to school at age 7. The second author has photographs from the early 1980s of 'classroom rules' and 'school rules' insisting that non English languages should not be used in class or the playground, with various reprimands detailed if students were caught disobeying these rules.

The school curriculum mirrored one from the colonial power Australia. With independence gained in 1975, gradually elements of the curriculum drew more and more on PNG cultures, although as in many ex-colonies, the impact of the western curriculum is still very obvious. Teaching too is still heavily influenced by western ideas with Australia regularly providing 'aid money' to 'upgrade' the quality of teachers and their preparation (Clarkson, Hamadi, Kaleva, Owens, & Toomey, 2004). There is a growing voice however that such aid money is perpetuating the global education hegemony, and it is time for PNG to develop its own style of teaching (Nongkas, 2007), which indeed is emerging (Pickford, 2008). But one far ranging decision made in the late 1990s that saw a definite break with much western education practice was for the early years of schooling in PNG schools to become multi lingual.

The PNG mathematics curriculum has also been impacted by the various general trends in the school curriculum. Some use has been made of indigenous mathematics (Lean, 1994; Muke, 2001), although there is much scope for more of this to take place. It has been recognised for many years that the mathematics performance of PNG students in part relies on their language abilities (Clarkson, 1983), but more their performance on a variety of mathematics tests, and indeed on system examinations covering language and general studies as well, is in part dependent on their competence in their various languages (Clarkson, 1992; Clarkson & Clarkson, 1993). Such results are mirrored by other studies elsewhere in the world (Barwell, 2008). However these early research projects in PNG only studied urban students, and only looked at the interplay of two of the multi lingual students' languages; Pidgin (the common lingua franca in the northern parts of PNG) and English (the language of schooling and the dominant language of commerce). However, most school students attend rural schools, and know three or four languages, but rarely English, when commencing school. The early studies also did not analyse the teaching of mathematics but concentrated on students' learning and understanding of mathematics.

The present study

The study describe in this paper focuses on the teaching of year 3 mathematics in four PNG rural primary schools. The year level is important. In the new curriculum the first three years of schooling is undertaken in Elementary Schools (Prep, years 1 and 2). In these schools the curriculum indicates that local languages should be used for teaching, although some schools in urban areas do opt to use English. After year 2, students move to primary schools which span years 3 to 8. Year 3 is marked as the 'bridging year' in teaching. During this year it is anticipated that the language of teaching will be a mixture of the languages used in the Elementary school, with a lingua franca if not already used in year 2, and the gradually introduction of English. It is expected that by year 5 all teaching will be in English, although the curriculum documents suggest use of other languages if the teacher gauges that would help the learning of students. This situation applies to all curriculum areas including mathematics.

Potentially, there are a number of possibilities for teachers teaching in a multilingual context to pursue. They could just decide on the simplest approach to stay with the dominant teaching language. On the other hand they may decide to use other languages available, but only switching from the dominant teaching language when students are having difficulties in understanding mathematical concepts, or an indigenous language

may be called for when analysing a problem drawn from the local culture. The context becomes more complex if the teacher takes seriously the progression from using the everyday language of the students through to formal mathematical language, Some of this complexity has been portrayed diagrammatically elsewhere (Clarkson, 2009). For this study the work by Setati and Adler (2001) was important. They mapped out possibilities for teachers' use of language in multi lingual mathematics classroom in South African classrooms on a number of dimensions. One dimension was the possibilities available as teachers and students moved from the informal to the needed formal mathematical language. Another was moving between the various vernaculars spoken by teachers and students. A third was moving back and forth between managerial and conceptual teaching discourses.

The authors were aware that many teachers in PNG also believe that the learning of mathematics has little to do with student language competencies. Moreover we were cognisant of the fact that teacher college educators did not believe that the notions of the 'bridging year' had implications for how mathematics was taught in year 3, since mathematics was a language free zone (Clarkson et al., 2004). Nevertheless anecdotal evidence was available to both authors from their own observations of PNG classrooms that occasionally good teachers of mathematics, even before the change to the curriculum, would switch languages when teaching mathematics, if they felt the need to do so. However why they did so to our knowledge has never been explored. Thus the focus for this study became:

1. Did the teachers use a variety of languages when teaching mathematics and if so was there a consistent pattern to this usage for individual teachers and/or topic?
2. If teachers did use multiple languages in their teaching, why did they?

Methodology

This study was conducted in four primary schools in the rural Wahgi Valley of the western Highlands of PNG. All schools are some days' travel from the main town of the province Mt Hagen. The eight year three teachers were all fluent English and Pidgin speakers, and all knew the local vernacular Wahgi, and could speak other languages as well. The year 3 students were for their age fluent in Wahgi, Pidgin, knew some English, and often knew some other language(s) as well. The schools by western standards had few resources, but by PNG standards had normal resources to draw on. They certainly had dedicated teachers.

The first author observed a number of classes taught by the teachers. Although it had been planned to observe three classes for each teacher, each separated by a six month interval, because of logistic difficulties this did not occur (Valero & Vithal, 1998). As it turned out three teachers were observed for three lessons, two for two lessons, and the remaining three teachers for a single lesson giving 16 observed lessons in total. Each lesson was video and audio recorded. Teachers were interviewed briefly before each lesson, and a post lesson interview of some 60 minutes was conducted on the day of the lesson. All recordings of the lessons were transcribed as were the interviews. During each lesson the first author also completed field notes, concentrating particularly on the language of the teacher, the context in which that language occurred, the segment of the lesson, and content of the teaching. The video recording of the lesson was available

during the interview, and if it helped the discussion, segments were often replayed at either the author's or teacher's instigation.

The transcription data from the lessons were analysed by sentence for the types of languages used during the lesson, and at what points the teacher switched between languages. The author made a judgement of language use on the basis of semantics and syntax of the sentence. For the vast majority of sentences this was clear cut. The instances of using an isolated borrowed word (often a formal mathematical term in English) were noted, but did not impact on the decision of language categorisation. The interviews were analysed to find the perception of the teachers as to why they used multiple languages in their teaching, and why they switched between languages when they did (Gee, 1999).

Results

Research question 1

In the 16 observed lessons, instances of the use of Wahgi, Pidgin and English were all noted except for two lessons when Wahgi was not used and one lesson when English was not used. As shown elsewhere (Muke & Clarkson, in press) about half the teachers' language use was in Pidgin with the remainder divided about equally between Wahgi and English. The same pattern of language use was not consistent from lesson to lesson for teachers who gave multiple lessons. Nor did the mathematical topic of the lesson seem to be the determinant of language usage.

It has been noted above that sentences were the unit used to estimate the frequency of 'language use'. However many formal mathematical terms/phrases expressed in English were borrowed even though the overall sentence was in one of the local languages. Table 1 shows the topics taught by the teachers and the specific terms borrowed into Wahgi and Pidgin. One feature of this listing is the variety of terms borrowed. The higher frequency of terms borrowed into Pidgin is probably just a function of the greater use made of Pidgin by teachers.

Research question 2

One way to explore why teachers switched languages in their teaching is to look at the types of language switches Setati and Adler (2001) referred to as code-borrowing and code-mixing. Both were observed in this study. Code-borrowing refers to a switch that involves borrowing either a term or a phrase from a different language and using it in a sentence constructed in another language. Similarly code-mixing refers to a sentence made up of two languages, where one language is used to start the sentence and the other completes the sentence.

First, code-borrowing that involved a single term in another language and used within a sentence constructed in another language will be considered, followed by that of borrowing a phrase. In this study, most terms that were borrowed by teachers were from a mathematical register, and the overwhelming majority of these terms were from the mathematical English register. As Skiba (1997) noted, one of the skills of a bilingual or multilingual speaker is to use such borrowed terms within the grammatical rules of the sentence, which is in the other language. The two main parts of most sentences are a noun phrase and a verb phrase (Skiba, 1997). Teachers observed in this study always used terms from the formal mathematical English register as a noun. This meant that the

verb phrases, the rest of the sentences, were commonly in one of the local languages. To illustrate this, an excerpt from the transcription of one of the three lessons given by Mr. W will be examined.

Table 1. English formal terms borrowed when using Wahgi or Pidgin.

Teacher / Lesson no.	Lesson topics	English mathematical terms borrowed into:	
		Wahgi	Pidgin
Mr M / L1 Mr M / L2 Mrs K / L1 Mrs K / L3 Mr J / L1 Mr J / L2 Mrs T / L1	Number operations	*a* groups of *b*, carry, division, group, multiplication, multiply, names of place columns, number names, multiples of *x*, number, plus, subtract, times table, times	*a* groups of *b*, $a \times b$ equals, addition, all together, carry, count, divide, divided, division, equals, groups of, multiples, multiplication, multiply, names of place columns, number names, number, place value, plus, put down, subtract, takeaway, times table, times, zero
Mr M / L3 Mr W / L2 Mr A / L1	Fraction	half, quarters, one whole, quarter	whole, half, quarter, number names, fraction, one whole, parts, one fourth, two thirds, three fourths, one sixth, four sixths, fractions, square
Mrs K / L2 Mr D / L1 Mr D / L2 Mr K / L1	Measurement	guess, measurement, meter, perimeter, meters, number names, weight, length, units, grams, kilograms, tonnes, true, false, units of measuring, weight	measurement, millimetres, centimetres, meters, kilometres, 10mm = 1cm, 100cm = 1m, 1000m = 1km, meter ruler, number names, guess, weight, grams, kilograms, perimeter, shapes, metres, number, milligrams
Mr W / L1	Number		number chart, numbers, words, objects, number names
Mr W / L3	Shape		shapes, kite, corner, rectangle, measurement, triangle, square, oblong, angle, rhombus, trapezium, diamond, pentagon, number names

An examination of the transcriptions of Mr W's overall language combinations in these three lessons showed that he responded to the language need of each lesson without using a particular language combination. The topic for this lesson was fractions, and Mr W is asking students what a fraction is:

Mr W: Lesson 2, Paragraph 17 & 18 (original in Pidgin & English)
17. Mr W: Okay, what is a fraction? … Fraction, em wanem samting? …Meaning bilong em olsem … a small part of a thing. A small part of a …
18. Children: Thing

English Translation
17. Mr W: Okay, what is a fraction? … Fraction, what is it? The meaning belongs to it/him/her is… a small part of a thing. A small part of a …
18. Children: Thing

The language combination Mr W used in lesson 2 was 78% of Pidgin and hence the leading language for this lesson, with 16% of English as the first supportive language, and 2% of Wahgi as the second supportive language. The two languages used in paragraph 17 by Mr. W were Pidgin and English. The first sentence is a question in

English, asking for the meaning of the term 'fraction'. Although in this lesson English was used far less often than Pidgin, the teacher felt the need to ask the question in English at the beginning of this paragraph. Later analysis showed that Mr W had a desire to model English, particularly so that students could listen to questions in English and hence be more prepared for test situations where items were always written in English. The second sentence of the excerpt is in Pidgin and repeats the question first asked in English. What is of immediate interest here is the code-borrowing occurring in the second sentence with the word 'fraction'. The sentence is constructed in Pidgin in such a manner that enables the borrowing of mathematical term in English, but uses correct grammar for Pidgin. The question asked in Pidgin is; "Fraction*, em wanem samting*?" and when translated word for word; "fraction; it (em) what (wanem) thing (samting)', which is understood as; fraction, what is it? The word '*em*' in Pidgin is a pronoun and it is used as 'it' to refer to 'fraction' as a thing. It is common in Pidgin to use the pronoun immediately after the name of a thing is used. Such an expression in this type of sentence shows that in this case the term fraction was used as a noun phrase, and the rest of the sentence in Pidgin formed the verb phrase. This means that the local language, in this case Pidgin, was used as a verb phrase, promoting the noun. The implication follows that for this sentence the local language took up a supportive role to the promotion of English.

The third sentence in the above excerpt involved code-mixing. Code-mixing is where a single sentence is completed by two different languages. In this case, the first part of the sentence is in Pidgin and the second part is in English. As translated, Pidgin was used to introduce the formal meaning of fraction. In Pidgin, the teacher said; "*meaning bilong em olsem"* which means the definition belongs to it, where the word *em* used as 'it' in Pidgin referring to the term fraction, and then switched to English to actually say the formal meaning in English; 'a small part of a thing'. The way Pidgin, the local language, is used here is that it is used as a pointer; directing students to be aware of the coming of an important thing. In this case it is not only the formal definition that is pointed to, but coincidentally this definition is expressed in English, and this language switch becomes part of the important designation of which students are to take note. Hence the students' fluently spoken local language is used to help students be aware of the formal mathematical concepts expressed in English. Therefore, the local language is given only the supportive role in this not unusual switching incident.

Another example will elaborate this issue further. One lesson given by Mr K was observed in this study. In this lesson Mr K used nearly the same amount of Wahgi (46%) and English (43%) with only very few sentences in Pidgin (5%). The following excerpt from the transcription of the lesson shows how Mr K borrowed a phrase in one language, a formal mathematical expression in English, but used this in a grammatically correct sentence constructed in Wahgi. The topic of this lesson was measurement and Mr K is singling to the class a new direction that the lesson will take:

Mr K: Lesson 1, Paragraph 13 (original in Wahgi & English)
13. Mr K: kinim ya units of measurement, ah units of measuring weight kanamin eh. Kanamin eh, mi mene units kembis woi kan wo ep mine units okma kanamin eh.

English Translation
13. Mr K: We will now look at 'units of measuring weight'. We will look at the smallest unit to the biggest units.

The sentence is constructed in Wahgi and the borrowed mathematical English terms and phrase are borrowed and inserted within the sentence. The phrase borrowed here is 'units of measuring weight' and the word borrowed is 'unit'. Both are examples of formal mathematical language, but both are expressed in English. The way this was expressed in Wahgi was, 'we will look at *units of measuring weight*, from smallest to the biggest *units*'. Both the borrowed formal mathematical English term and phrase acted as nouns in each sentence. The rest of the sentences were in Wahgi, and formed verb phrases. In the first sentence, Wahgi is used to say that they (the class as a whole) were going to do the 'looking at' or studying. As the teacher continued he said that the looking at or studying was going to involve the 'units of measurement'. This indicated that the teacher used the fluently spoken local language to inform the students what they would be doing, which is obviously forming the verb phrase, to the unit of measuring weight, the noun phrase. In the second sentence, the teacher becomes more specific regarding what they will be looking at or studying in the lesson. In Wahgi the teacher explains that they will be looking at or studying the smallest to the biggest, and this will involve the units, the core term which forms the noun phrase but again expressed in English.

These two examples show common constructions of teachers observed in the study. Often teachers used the local languages to construct grammatically correct sentences, but inserted borrowed formal mathematical terms using English. In doing so the mathematical terms and the language in which they were expressed, English, became the focus of the discourse, with the local languages playing supportive roles only.

Summary

After more than a century since schooling was introduced to PNG the indigenous cultures are starting to impact on teaching. Although the results noted in this paper are from only a limited number of teachers, their purposeful use of the variety of languages available to them and their students we suspect is mirrored in many classrooms throughout PNG. We note that although research for some years has suggested that multilingual students gain cognitive advantage if they are encouraged to use all their languages, this was not a factor for the reasons given by teachers for their exploiting of the multiple language environment. A key finding which would be well worth exploring with many more teachers is the way Wahgi and Pidgin were used, not to explore the nuances of the languages, but to learn the dominant language of English. It would be interesting to know whether this is an indication of the hegemonic impact of globalisation, even in the remote villagers of the western highlands of PNG.

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