The Role of Local Languages in Teaching Mathematics in the Bridging Class (grade 3) within South Wahgi Area of Jiwaka Province,

Papua New Guinea.

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STATEMENT OF SOURCE

This thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded of any other degree or diploma in any other tertiary institution.

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No other person's work has been used without due acknowledgement in the main text of the thesis.

All research procedures reported in the thesis received the approval of the relevant Ethics Committee.

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Charly Muke

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Glossary

PNG – Papua New Guinea

LoLT – Language of Learning and Teaching

ANC – African National Congress

LANGTAG - Language Plan Task Group MKO- More Knowledgeable Others

ZPD - Zone of Proximal Development

L1 – First Language

L2 – Second Language

IRF - Initiation-Response-Feedback

IRE - Teacher Initiation-Student Response-Teacher evaluation

VTPS - Viles Tok Ples Skul

TPPS - Tok Ples Pri Skul

P.M.S - Primary Mathematics Series

MaPS - Mathematics for Primary Schools

MaCS - Mathematics for Community Schools

Prep – Preparatory grade

E1 – Elementary grade 1

E2 – Elementary grade 2

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ABSTRACT

Knowledge can be perceived to be constructed personally without external physical or social influence (Von Glasserfield, 1995). To think this way does not do justice to the potential of human knowledge, which could also be shared through communication in situations such as schooling and thus become a group possession (Mercer, 1995). In schools, communication is the vital link between teaching and learning. If learning is achieved only as a result of personal cognition, it would deny the important roles of teaching, a communication process that aims at guiding learning (Vygotsky, 1986). Teachers use language as the primary medium for achieving this task. As Mercer (1995) indicates, teachers' language-use in the teaching process guides knowledge-construction that often results in effective learning. However, most classrooms in the world are multilingual (Clarkson, 2006), and how communication occurs within these classrooms becomes even more complex. According to bilingual theory, balanced bilinguals or multilinguals (able to speak all languages fluently) have the advantage of enhanced cognitive processes, compared to other students (Cummins, 1985). The students that were part of this study were in grade 3, the first grade of the bottom-up primary schooling in the Wahgi area of Jiwaka province, Papua New Guinea. They were in an additive stage of their language development: learning English as an additional language to other fluently spoken languages: *Wahgi* and *Pidgin*. The government of Papua New Guinea, which had been using an English-only policy for teaching, recognized this challenge tolearning. In 1992, the policy changed, and the new language policy recommended a 'bridging process' at the lower primary sector. This meant that a fluently spoken local language should be used as a resource to help these unbalanced-language multilingual students learn effectively. In this study the learning they engaged with was mathematics.

This study aimed to assess this policy by specifically studying the educational role of the local languages when alternated purposefully as a resource through code-switching during the teaching process. The study observed eight teachers in 'bottom-up' primary schools within South-Wahgi speaking areas of Jiwaka province, Papua New Guinea. These teachers all used the local languages and English in their teaching. The study found the purpose of code-switching and alternating the local language was mainly to enhance the teaching process, increasing the potential for effectively guiding unbalanced multilingual students in mathematics lessons. The teachers believed and showed through their teaching processes that, in order to guide unbalanced multilingual grade 3 students in learning mathematical English and mathematical content successfully, they needed the use of their local languages and cultural knowledge. However, the data shows that the crucial

endpoint in the teachers' minds always remained the learning of mathematics in English. This result confirmed that the new language policy for the lower primary education in Papua New Guinea, which recommended the use of the local language as a teaching and learning resource, was enhancing the teaching process. This study did not target learning through such a teaching process, but it appeared there was a greater potential for the unbalanced students to be guided effectively if teachers purposefully code-switched and used the local language as a resource when introducing mathematical knowledge expressed in English.

CHAPTER ONE INTRODUCTION

1.1 Introduction

In 1992 Papua New Guinea (PNG) changed its language policy for teaching in schools. The new policy ushered in a form of bilingual education, where the local languages that students speak fluently would now be used as a resource to introduce English. This was a change from a strict policy of using only English as the language of instruction in all sectors of the schooling system.

The old language policy was part of the colonial rule inherited from Australia. After independence from Australia in 1975, for political reasons the new government of PNG decided that schools would continue to use only English as the language of instruction (Clarkson,1991; Matane,1986). However, the recent policy change now recognizes that the 800+ native local languages, the two lingua franca (*Motu* and *Pidgin*) and English all have complementary roles to play in Papua New Guinean schools (Clarkson,1991; Matane,1986; *National Curriculum Statement for Papua New Guinea*,2002).

One crucial element of the new policy means that there is a continued emphasis on and recognition of the importance of English, but the local language will be used as a resource to introduce English in all teaching. In the study that forms the core of this thesis, the emphasis will be on understanding how primary school teachers use their languages in teaching mathematics. Hence the emphasis throughout the thesis will be on learning mathematical English rather than English in its broader use. The new language policy was also specific in for what and how frequently each language would be used at each grade level of schooling (a detailed description is presented in Chapter 3). However, this study was specifically interested in the aspects of policy that dealt with the 'bridging processes' for grade-3 class. Grade 3 was the first grade of primary education, building on two years of elementary schooling during which local vernacular languages were used for teaching. In grade 3, for the first time, students were introduced to formal English. In the policy the 'bridging process' recommended that the fluently spoken local languages were to be used as a resource or ‘bridge’ to introduce English. This process involved the language practice of code-switching, alternating between English and the local language as a teaching resource. Therefore, this study aimed to determine the purpose of code-switching, which had the potential to guide learning effectively and to determine what kinds of roles the teachers gave to the local languages as they sought to use them as such a resource.

In this chapter I will briefly sketch out some of the context for the study: education in Papua New Guinea and the teachers in Papua New Guinea primary schools. Although these aspects will be more thoroughly examined in Chapter 3, what is done here will be sufficient to show the significance of the research questions that guide this thesis and with which this chapter concludes.

1.2 Changes in Education Policy in Papua New Guinea

Before independence in 1975, under colonial rule, the policy for all schooling was to use English only for all teaching. Like many colonial powers elsewhere, the authorities’ aim was to train small elite of English-speaking professionals who would eventually be able to take over the governance of the country. For those who were unable to complete schooling beyond year 6 or 8, at least some grasp of English would bring access to the cash economy that was growing in PNG. Within the same time of colonial rule, the missionary schools in the main had a different system; they utilized the various vernaculars in early years of primary school before transitioning to English by years 4-5. This meant many church-based school students were able to read the Bible where it had or was being translated into the local vernacular. However, being able to communicate in English was also a priority for these schools by the time students completed primary education, for the same reasons as the government schools. At independence from Australia in 1975, the newly independent nation opted to stay with the colonial policy of the government schools and required the missionary schools to change their policy. This was not an unusual policy for new independent nations and was seen in many new independent African countries in the 1960s when they adopted English or French for education, depending on the language of the past colonial power.

When a new wave of policy makers emerged in the late 1980s and early 1990s, the policy shifted again. The language policy was varied for each sector of schooling. The specifics of how each language was to be used will be presented in Chapter 3, but it is useful to summarize here. The variation in language-use was in line with new structural changes for the schooling system also implemented at the same time. Figure 1.1 compares the old and new structure of the system. Before the education reform there were community schools (grades 1-6; aged 8-13); high schools (grades 7-10; aged 14-17) and national high schools (grades 11-12; aged 18-19). After the education reform the new structure included elementary schools (prep, E1 & E2; aged 6-9); primary schools (grades 3-8; aged 10-15); and secondary schools (grades 9-12; aged 16-19). It is within this new schooling structure that the language policy was to operate.

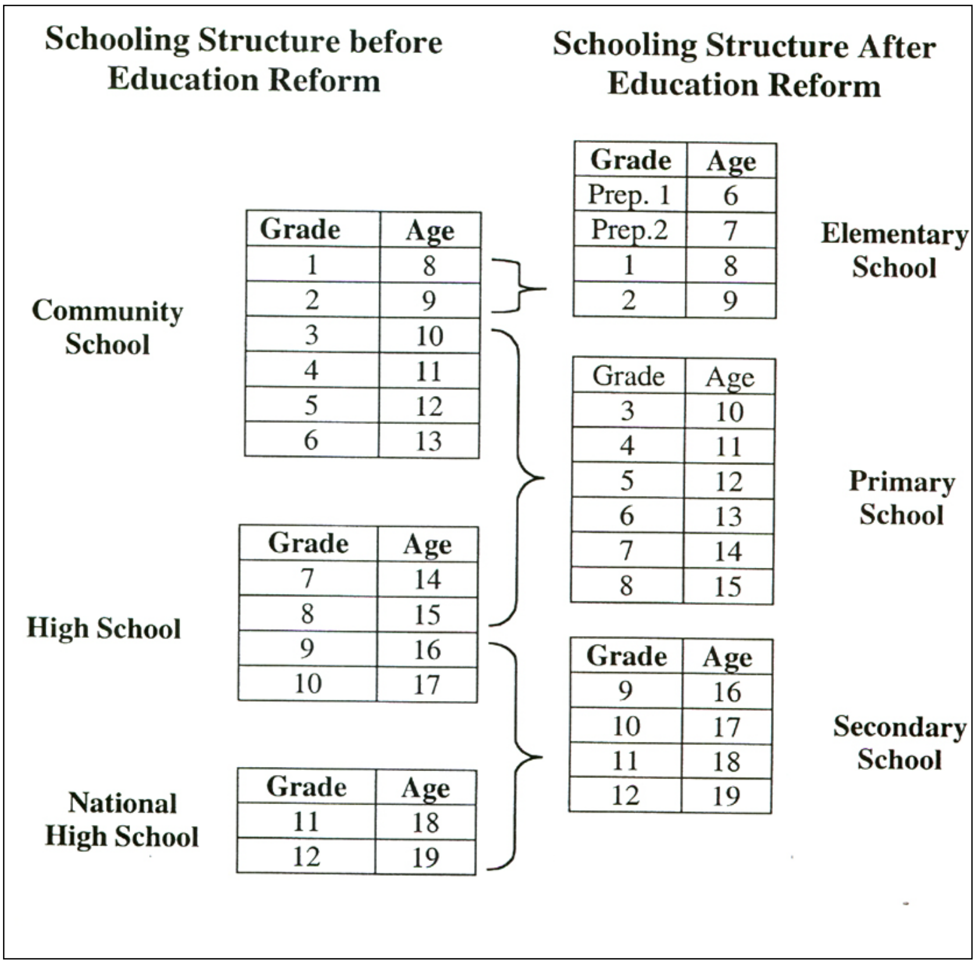

Figure 1.1: The Change in PNG Schooling Structure (Muke, 2001)

The change in language policy targeted the two new schooling sectors: the elementary schools and the primary school. As the National Curriculum Statement (2002, pp. 18-19) described this policy; “the students’ vernaculars are the languages of instruction for the first three years of education at the elementary level of schooling. In line with the language policy for elementary, oral English is introduced towards the end of elementary 2”. The policy also added; “in line with the language policy for the lower primary, students at grade 3 will begin to learn to speak, listen, read and write in English (referred to as bridging to English) as well as continue to develop their first languages”. This policy suggested that a local language that the majority of students could speak fluently in a particular school should be used as a resource to teach English, and other subjects would be taught both in the local language and English in the bridging class. Hence it was envisaged that the children who came to grade 3 to begin their primary schooling would have attended elementary schools for three years. The language used at elementary schooling would have been the students’ local language(s) (*National Curriculum Statement for Papua New Guinea*, 2002). This means that grade 1 at elementary schools should use only the local language, and in grade 2 teachers could use a little oral English, if the students were ready for this. But during grade 3, the policy stated that teachers should progressively use more English. However, it was anticipated that, even by the end of grade 3, there would still be a mixture of languages used by the teacher. This process was expected to end after grade 5, when English was to be used as the language of instruction at most times.

It is the bridging class of grade 3, and the way teachers used their mixture of languages when teaching mathematics, and why they did so, which is the primary focus of this study. The results will also gauge the extent to which the new language policy was implemented by the teachers.

1.3 The Researcher’s Background and Experience as a Student

Since the researcher is a Papua New Guinean teacher, his background will have an inevitable impact on the study that is at the heart of this thesis. As will be explained in Chapter 4, he is the quintessential participant researcher. Therefore, one of the crucial factors that contributed to this study (and the researcher believes in a positive way in data collection, data analysis and reporting in particular) was the researcher's background. The background of the researcher is presented in this section in three parts. The first part describes his language background, which includes his parents' languages that he eventually learned to speak, and the language he deliberately decided to use with his children. In the second part he discusses his schooling experience as a multilingual when the old language policy was in force. The third part briefly describes his teaching experience, specifically at Community Schools, which are now called Primary Schools. His personal experiences made him an informed ethnographer for this research study.

1.3.1 Language Background

The researcher's parents have two different ethnic and linguistic backgrounds. His father is from the Jiwaka Province and his mother is from Simbu Province. Therefore, his father's local language is *Wahgi* (South *Wahgi* dialect, as compared to North *Wahgi* dialect) and his mother's local language is *Kuman*. They both speak each other's language. His father can also speak *Pidgin* and his mother indicates that she understands *Pidgin* but does not use it in conversation. His father and mother have never been to school; therefore they could not write or speak in English. With such a family language background, the researcher learnt to speak both of his parents' local languages; *Wahgi* and *Kuman*. He also speaks *Pidgin* and English. He also speaks and understands the North *Wahgi* dialect.

As any modern Papua New Guinean working dad would have done, he decided to allow his children's first language to be *Pidgin*. Through his own experience, he realized that the English language was important for success and access to better information and power. It came to his attention through his own schooling and teaching experiences that those who spoke *Pidgin* were able to learn English quickly, and they also easily understood any school content taught in English. Therefore, for the best interest of his children, he chose *Pidgin* as their first language. The second language they spoke was certainly English. Their fluency was improved when he took them to New Zealand while doing his Master's Degree for two years. The third language he hears them beginning to learn is his local language, *Wahgi*. It is mainly through the influence of their grandparents, extended family and the whole tribe that the children are learning this language. The researcher also uses *Kuman* sometimes at home with his mum, although he is not sure whether the children have learnt much of this language.

His assessment is that his children are able to speak three languages to this date, with some understanding of a fourth.

The three languages that he speaks, namely *Wahgi*, *Pidgin* and *English,* are the focus of this study. Where an ethnographer could spend a substantial amount of time learning to understand the languages as part of the initial stages of research, he has learned them during his entire life. He learned them and has used them fluently for communication purposes across his forty years. However, given his interests in language, he is also informed of the languages' structural capabilities and limitations. This became very important in relation to the language-switching and the patterns that emerged during the classroom observations that were made during this study. Therefore, his language background assisted him in many ways in this study.

1.3.2 Experience of Language-Use at School

As indicated earlier, the researcher was able to speak both local languages of his parents and *Pidgin* before he attended his first grade in 1977 at the age of seven (7) in the nearby Community School (now called Primary School). At school, the language to be used for learning and teaching was only English. When he arrived at the school for the first time, he was not given any choice of languages, but had to speak only English in the school premises. As he recalled, the first rule in the list of class rules pinned on the wall was always 'that students must speak English at school'. They were punished severely for speaking their own local vernacular, either inside or outside of the classroom. If they were lucky, they would be told to write 100-200 times the phrase; 'I must speak English at all times'. Otherwise, they received smacks on their backsides with a cane stick in front of the whole school during assembly, or other corporal punishment during schooling hours.

In the classroom situation, the researcher recalls some things that went on in his mind. As he was listening, he desired to understand what was going on, therefore most times he remembered trying to translate what he heard in English into one of the languages he spoke, to match the concept to a context and situation that matched his experience from his background. By the time he finished checking his background in his mind and understood, he had to translate what he understood into English, in which he could not speak even a sentence. He could not say what he wanted to say in his language because he would have been punished. The best strategy available to him was to be silent during lessons, even though some activities related to the lesson were going on in his mind. He spoke in only one- or two-word English sentences when he was questioned by the teacher. In most cases, he would bow his head or scratch his head and say nothing. He had some idea of what was going on in class, but he had no way to say it to the teacher correctly. Making mistakes in front of an elder such as a teacher was culturally insulting for him, and this also kept him silent (Muke,2001). His teachers shouted at him, pulled his ears, gave him a knock on his head, or would tell him to stand on one leg at the back while listening to the lesson's progress.

The classroom was a painful and shameful area to be for him, but he had to go through the six years of his education at the community school with great determination because his parents kept emphasizing that school was the doorway to the good life. He was determined to get there and make his family and tribe happy. After the six years of community school, he went to high school for four years. He improved a lot in his English at high school, but it was not good enough to tell a story and start a conversation with anyone. After high school, he went to St Benedict's Teachers College for two years. He felt that he improved in his English at the Teachers College and finally returned to a community school as a teacher, to use only English to teach in 1990.

With this experience as a multilingual learner, and now being a researcher, he saw himself being well informed of potential patterns of language use that are at least potentially suitable from a learner's point of view. He hoped this made it easier for him to gain insights into how multiple languages can be used to help students' learning. His personal experience should allow him greater insight in interpreting observations made of the multi-language teaching in PNG classrooms than would be available to monolingual classrooms.

1.3.3 Language use in Teaching

The researcher had taught in almost all sectors of schooling. He started as a community-school teacher. After completing further studies, he taught at high schools and then taught as lecturer at both primary and secondary teachers colleges. However, this section will describe his teaching experience at the community schools, since it is this that is most pertinent to the present study. While he was teaching at the community school, among other things, he believed that his teaching would be effective if he often involved his students both verbally and mentally. He knew that if children could actually participate in doing, discussing, arguing, justifying and inventing for themselves during his lessons, then they would be more likely to learn effectively. They would understand more and be creative in their thinking. Therefore, he always prepared his lessons so that he was clearly focusing on the child as an active learner. However, his lessons hardly ever turned out that way. He felt that he never succeeded in teaching. He would end up talking most of the time, doing almost half of the problems for the children, and would always be guiding them closely to get them doing problems correctly in the time available. At the end of the lesson, he would have mixed happy that he had completed his tasks that he had planned for the lesson, but seriously wondering if the children had learnt anything. They tended to use the skills that he suggested, rather than the ones they understood best. It seemed that children viewed what he, as a teacher, said and suggested was the only right way to do problems, and did not use their own ways that may have made greater sense to them.

There was a mixture of reasons that could have hindered his lessons from becoming child-centered. Four of these reasons he has discussed previously (Muke, 2001). They related to cultural views of knowledge and learning; the power of existing cultural practices; the influence of teacher beliefs; and the difficulties associated with learning in a second language. The latter reason is particularly related to this study. During his teaching, the rule to use only English as the language of teaching was still enforced. Hence teaching was all in English, and he expected any learning situation he provided for the children would occur while using English, either by speaking, listening, writing or reading in it. Even though he knew that almost every child in the class spoke another language, and hence English was a new language for all of them, he emphasized that they should participate in English conversations at school. As he indicated earlier, his lessons did not have the character of student-centered lessons as much as he had planned. With his own school experience, he could see that the children he was teaching tried to learn and understand the English language, and they were also trying to learn and understand the mathematics at the same time (Muke, 2001). There was nothing wrong with their effort, as indeed there had not been with his. Consequently, the children had to take in the message in English, translate it into their own language, try to understand it, and then translate from their language to English to respond and participate in the class, just as he had when he was a boy. By the time they had gone through this process in their mind, the lesson had already moved on, just like it had for him. In other words, the processing that involved moving to and fro between two languages needed time. But the lesson moved too fast to allow this to happen, and hence they could not keep up with the flow. Therefore, he ended up doing most of the activities himself, instead of students, and hence his lessons were far from involving students effectively.

The researcher's concern for the children's learning prompted him to try to use the local language or *Pidgin* sometimes, to explain or reformulate important statements or questions, even though the education policy did not allow this practice. But he realized that using such practices helped the children a lot. Especially it helped students to understand. However, he often got into trouble for doing this. It was not only that he got into trouble with the school inspector for using too much local language or *Pidgin*, but he got into trouble with parents. One incident he remembers from 1993 is just one example of many. A father approached him to tell the researcher that his child must be spoken to only in English and not in any other language. The father thought that by listening to the teacher in English quite often, his child would learn English quickly. The father thought that the researcher (then teacher) was inhibiting his child from learning English when he switched language. As a teacher, he could not argue, but had to balance the demand of the parents' and school's administration with furthering the understanding of his students. It was hard, but he thought he managed this well, achieving an appropriate balance between the demands of these groups.

This research project is about studying the role local languages play in the teaching of mathematics. Even though the Government policy of the time when the researcher was a community-school teacher did not allow him to use local languages in his teaching, he has indicated that during his teaching experience he did use the local languages from time to time. One of the reasons for this was that he was aware of the beneficial role the local language seemed to play in his teaching, in that it enhanced understanding and successful learning by the students. Since he saw this as a vital teaching strategy in a bilingual or multilingual classroom situation, it motivated him to understand this practice better and find ways the wider community of teachers might use it through a properly set-out scientific study.

1.4 Wider Significance of 1990 Policy Change

The multilingual classroom context, as described in section 1.2, and its negative impacts, as illustrated through the researcher's experience as related in section 1.3, were not only found in classrooms in Papua New Guinea. This context had grown into a major concern for many people throughout the entire world. As Clarkson (2009) noted, the most frequent classroom-language context in the world is either bilingual or multilingual. The impacts of learning related to such language contexts in classroom situations have been the centre of many studies for a long time. Such studies, including that of Cummins (1981a-b), which will become a core set of ideas for this study, have shown there can be many positives if the multilingual context is used to the advantage of the students. The details of these possibilities will be explored in Chapter 2.

In many countries that were once colonies, the language policies of such nation often privilege a foreign international language, such as English, as their official language, or at least one of a small group of official languages. Such a policy normally forces students to learn the official language, as part of an assumption that they will be prepared as part of an elite who will eventually run the nation and communicate with the rest of the world. However, some countries have become aware of the unbalanced environment created through such a policy and the impacts this can have on learning within the classroom. These countries have opted for a policy that seeks to be fair, but which continues to promote the official language. The way forward, for these countries, seems to be to recommend the use of the fluently spoken students' language(s) through the language practice of code-switching for teaching and learning in early years of schooling, as a resource to introduce the highly valued foreign and official language. Such a change was recognized in number of countries including South Africa (Setati & Addler, 2001), after the apartheid regime was overthrown, and obviously in Papua New Guinea, as indicated in the earlier section of this Chapter. Studies carried out in South African schools showed that often the fluently spoken students' languages were used by students through the language practice of code-switching. In that research this practice of switching between languages had the potential to guide multilingual students to learn the foreign language effectively, as well as the content related to each subject, such as mathematics. However, these South African studies had learning as their central focus, with less focus placed on how the teaching process could utilize the fluently spoken students' language(s) to effectively guide multilingual students to learn English effectively, and when the occasion arose the learning of mathematical English, and the mathematical content.

This study aimed to fill this gap. It set out to examine how the fluently spoken local languages of the students could be used through code-switching as a teaching tool to guide multi lingual students to learn effectively both mathematical English as a language and mathematical content. The rest of the thesis focuses on the practices of code-switching and shows what roles the teachers' local languages played in their teaching.

1.5 The Key Issue

This section discusses three key issues related for this study: the purpose of this study (sub-section 1.5.1), the significance of this study (sub-section 1.5.2), and the key research questions that guided this study (sub-section 1.5.3).

1.5.1 Purpose of this Study

The purpose of this study was to assess the implementation of the new language policy that recommended that teachers use the students' fluently spoken local languages to guide their effective learning of English, in particular when teaching mathematics. In order to do this, this study needed to gather results related to how the local languages were used within the teaching process of mathematics. Therefore, this study aimed to identify the role of local languages within mathematics teaching.

One way to do this was to select and investigate particular moments of teachers' verbal communication while they were teaching mathematics. The moments selected in this study were when the teachers used the language practice of code-switching. As indicated earlier, the purpose of code-switching was implied within the new language policy. Through the definition of bridging process, it was understood that the language practice of code-switching was an important resource, because the language practice enabled the purposeful use of the local language as an alternative to English, and hence enhanced teaching practice, which in turn lead to effective learning. According to Skiba (1997), the language practice of code-switching not only involves a shift between languages, but also involves specific skills that enabled bilinguals or multilinguals, in this case teachers, to switch to a more suitable language within certain moments of talking to enhance the communication process. This study set out to investigate the way teachers' used the practice of code-switching.

1.5.2 Significance of this Study

The underlying motive of this study was to assess the implementation of the current language policy in PNG schools, and in particular in the teaching of mathematics. This issue is significant in how it relates to a body of international research literature. Research from the literature, for example Arthur (1994), Clarkson (1991), and Setati and Adler (2001), suggests that using a language that students speak fluently, even if it is different to the dominant teaching language, helps in learning mathematics successfully. However, as indicated by Clarkson (2004), there have been very few research studies aimed at understanding the area of 'teaching' within a multilingual context in a mathematics classroom situation, compared to the many more studies that have focused on the bi/multilingual learner in this context. Therefore, the findings from this study will add to a body of important international research literature.

There is clearly a personal significance for this issue, given the researcher's own unfavorable personal school experience, when English was the only teaching language used. If such experiences can be prevented for present and future Papua New Guinean students, so much the better.

This study is also significant at another personal level, but transcends that, and raises an issue for teacher education in Papua New Guinea. During the time this researcher was a teacher in the late 1990s and then in the early 2000s first as a lecturer in a primary teachers college and then at the University of Goroka, where he lectured in pre-service programs for primary and secondary teachers, he taught mathematics as a subject as well as the teaching methods subjects. One of the things that became clear was that the issue of 'bridging' under the government's language policy was not addressed by the Mathematics Department. This issue was left to be dealt with by the Language Department. This has also been one of the major findings of an evaluation of Papua New Guinea's teacher education programs (Clarkson, Toomey, Owens, Kaleva & Hamadi, 2004). Pre-service education students need to be provided with opportunities to think about the links between language and mathematics learning, and in particular in multilingual classroom contexts. Clearly the results from this study will be important for teacher educators in Papua New Guinea as well as in other countries where students learn in multilingual context.

In addition there is potential significance for this study at a political level. At the national level in Papua New Guinea, policy makers might want to use the findings of this study to assess the progress of implementing the language policy, and depending on what the results are, there may be an argument for reconsidering at least aspects of that policy. At the Provincial level, the findings might be used to inform provincial in-service sessions for bridging class teachers.

1.5.3 The Key Research Questions

The main research questions that guided this study are listed below:

- What were the language context and practices found in grade 3 mathematics classes?
- What were the purposes of code-switching within mathematics teaching?
- What were teachers' perspectives of using the local languages and English in teaching?
- What were the roles of the local languages in teaching?

As has already been stated in previous sections of this chapter, the main research question for this study was to examine the role of the local language, but it is listed above as the last question. The order of these questions was arranged deliberately because the first three questions help to identify the context in which the role of local languages could be effectively identified. Figure 1.2 shows that to identify the role of local languages successfully, this study needed to examine the practices of code-switching within the bilingual or multilingual mathematics classroom context, to determine first the purpose of code-switching and, second, effectively distinguish the role of local language.

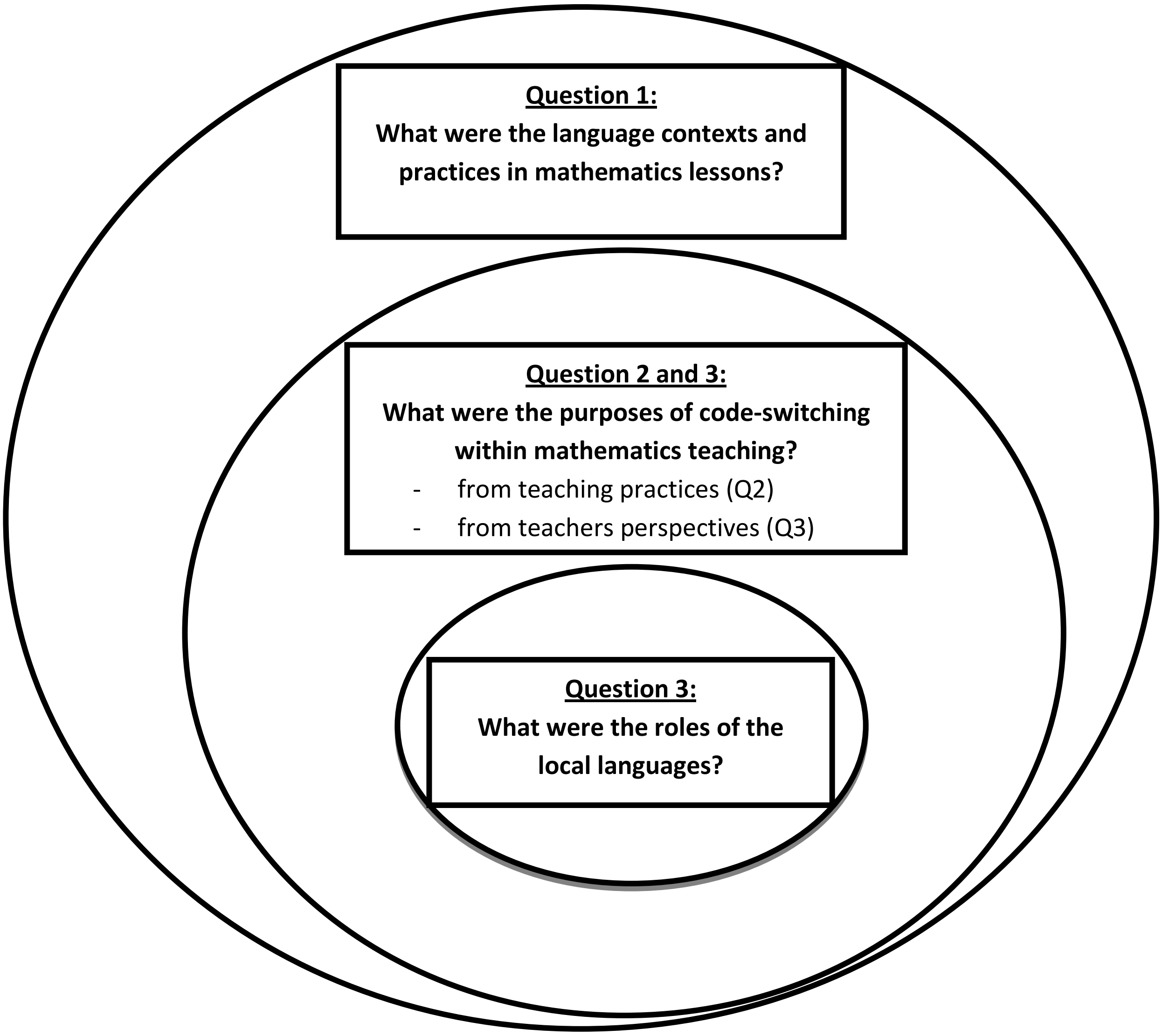

Figure 1.2: The Layer of Research Questions that Guided this Study

1.6 Thesis Outline

This thesis has eight chapters with this chapter, the first, introducing the thesis. There are two chapters dedicated to literature review. Chapter 2 reviews pertinent but significant international studies related to bi/multilingualism, mathematics and teaching. In Chapter 3, other studies undertaken in PNG related to bi/multilingualism, mathematics, teaching and language policy are reported. The description of research methodology adopted for this study for both data collection and analysis are presented in Chapter 4. The results of this study are presented in Chapters 5 and 6. Chapter 5 presents the results that distinguish the purpose of code-switching and identify the roles of local language as they are used as alternated language within mathematics discourse. Chapter 6 reports on language practices related to code-switching and alternating local languages found in teaching but within both mathematics discourse and non-mathematics discourse. This chapter also makes specific mention of an outstanding teacher identified as Teacher K. The results presented in these two chapters are summarized and discussed in Chapter 7 by using the four research questions to the frame discussion. Chapter 8 concludes this thesis.

2.1 Introduction

The literature review for this thesis had been divided into two parts. This chapter draws on literature related to languages used in the teaching process that may guide learning in bi/multilingual mathematics classroom. The emphasis will be on language-use within the practice of code-switching in a mathematics bi/multilingual classroom. Chapter 3 reviews literatures related to the use of more than one (bilingual) or two (multilingual) languages in the education system of Papua New Guinea.

2.2 Mathematics Subsumed in Culture

The aim of this section is to outline some pertinent background issues that have an impact on the process of teaching, and thus learning. These issues are related to the relationships between culture, mathematics and language, and the combined effect on the use of language in the language practice of code-switching. The particular context of interest is that of a bi/multilingual mathematics classroom. Of particular importance for this study is when students come to the classroom with traditional cultures and languages, mostly found in developing countries such as Papua New Guinea, and meet Western Culture and English in the classroom.

In order to do this, this section begins by defining culture and mathematics. It then discusses language and knowledge, including knowledge that relates to mathematics, and how they can be identified within cultures. Finally the effect that different cultures, identified by their languages, have on mathematical ideas embedded in their languages, is highlighted.

2.2.1 Definition of Culture and Mathematics

It is useful at this point to explore the definitions of the terms ‘culture’ and ‘mathematics’. The term ‘culture’ is subtle and multifaceted, and thus it has numerous definitions and elaborations. The most common theme, and what is significant here, is that in any culture the people share a language, a place, traditions, and ways of organizing, interpreting, conceptualizing, and giving meaning to their physical and social worlds (Ascher, 1991). For this discussion language and its attendant meaning is regarded as the knowledge of the culture. Within this cultural knowledge, mathematical knowledge is embedded.

Most traditional cultures, until recently, had no systems of writing (Ascher, 1991). As a result, there are no early written records by members of traditional cultures in their own words. But there were oral traditions. By researching such oral traditions it has become clear that there has been no single linear path along which all cultures have progressed. It has also become clear that most cultures share some ideas, but not others. Even where the ideas are the same or similar, they are differently nuanced and have different contexts in any given culture. This is true for mathematical ideas just as much as for other ideas. Hence, the Western expression of such ideas, including mathematical ideas, are but one of many (Ascher, 1991). As will be shown later in section 2.2.2, different cultures develop language and the embedded knowledge together. Therefore, it is not easy when two different cultures interact: it is challenging to use a language from one culture to express knowledge that has arisen in another culture. For instance, it is challenging to use traditional languages to teach western-based school mathematics. This is a situation where traditional language has developed at the same time with traditional mathematical ideas, but western school mathematical ideas have developed with English. Such challenges affect instruction in mathematics classroom, which is at the focus of this review.

There is no generally agreed-upon definition of mathematics. As Ascher (1991) noted, mathematics has meant to some whatever was included in their school or college courses, and to others whatever was done by the Western professional class called ‘mathematicians’. In general, however, what mathematics is has generally been a concern for philosophers and historians. Their opinions have changed through time as new lines of inquiry developed, as earlier assumptions were reexamined, and most particularly, as the ensemble of beliefs in the world around them changed (Ascher, 1991). In most cases, their definitions of mathematics were based solely on the Western experience, even though they were often phrased as if they were universal (Ascher, 1991; Barton, 1996; Bishop, 1988; D'Ambrosio, 1997). As a result, the category ‘mathematics’ as normally used in the literature is Western, and so by definition is not to be found in traditional cultures. But that is not to say that the ideas or concepts deemed mathematical do not exist in other cultures; it is rather that others have not distinguished or recognized them and do not class them in the same way as is done in Western culture. So, to avoid being constrained by the Western connotations of the word mathematics, the researcher uses the phrase Ascher (1991) proposed, ‘mathematical ideas’, to refer to mathematical ideas of all groups, including western as well as traditional cultural groups. Particular ideas, the way they are expressed, the context and ideational complex of which they are a part, vary depending on the culture (Ascher, 1991; Barton, 1996; D'Ambrosio, 1997). To distinguish between mathematical ideas from the traditional societies and mathematical ideas taught in schools which are in the main western, the researcher calls them ‘traditional mathematical ideas’ and ‘school mathematical ideas’ respectively.

These definitions bring to light one of the relationships between language and knowledge, in this case mathematical ideas. The relationship is that language and knowledge, including mathematical ideas, are developed together. The understanding of such a relationship is vital in using language for instructional purposes, and therefore the following section briefly discusses this relationship.

2.2.2 Relationship of Language and Knowledge (Mathematical Knowledge)

The details of how language may have been developed together with knowledge are not the focus of this study. However, it is useful to note the following: language and knowledge seem to have developed together using almost the same process. As Vygotsky (1962) explained, the basic outline of this process was a word in a language represented a meaning, building to a collection of words allowing deeper meanings, with the fabric of words eventually forming a language, which in turn allowed a wide network of ideas to form knowledge. Both language and the embedded knowledge became a culture, as described earlier. This means that every mathematical idea, both from traditional societies and western cultures, developed together with a language. The context concerned in this discussion includes the interaction between traditional mathematical ideas embedded in their traditional languages and school mathematical ideas embedded in a Western language. If language and knowledge are related in their development as described by Vygotsky (1978), using a language to express knowledge developed in a different culture and language will be challenging. The details of this challenge in language use, particularly for instructional purposes, will be discussed in detail in section 2.4 when aspects related to teaching are dealt with. But before dealing with that, it is important to show that traditional cultures do actually use mathematical knowledge embedded in their traditional languages. The following section will briefly present a review of studies that confirm the existence of such traditional mathematical ideas in different cultures of the world. The research field that studies traditional mathematical ideas and identifies impacts on the classroom process is ‘Ethnomathematics’. The mathematical ideas of traditional ideas are described below and their impact on learning is described later in section 2.3.

2.2.3 Ethnomathematics

The term Ethnomathematics was first proposed by D’Ambrosio (1997) in the early 1980s, but it has a number of definitions in the literature. Some use it to refer to the mathematical ideas of traditional people (Ascher, 1991). Others use it as a neutral term to refer to all home or cultural mathematical ideas that were excluded from school mathematics, both western and traditional cultures (D'Ambrosio, 1997). However, the definition that suits the purpose of this study was proposed by Barton (1996), where the term Ethnomathematics was referred to as a field of research that was dedicated to studying mathematical ideas of traditional societies, or other mathematical ideas that were normally excluded from school mathematics. Ethnomathematical research has identified mathematical ideas of traditional cultural groups of people. Detailed description of all these studies is not the focus of this section. But the researcher provides a snap-shot description of some studies. In this way the notion will be emphasized that mathematical ideas of traditional cultures do exist and are embedded in their relevant traditional languages.

The field of Ethnomathematics has identified mathematical ideas of many traditional cultures of the world. These studies included Gerdes' (1988, 1990) focus on the Mozambique weaving to illustrate mathematics and geometric thinking and mathematics in traditional sand drawing of Africa. Similarly, Kietel, Damerow and Bishop (1989) identified mathematical ideas from Africa and other parts of the world. Finau and Stilman (1995) studied the Tongan understanding of geometry through the skills identified in Tapa designs. McMurchy – Pilkington (1995) studied mathematical activities of Maori women in the Marae kitchen in New Zealand. Ascher (1991) studied and identified a number of traditional mathematical ideas, including sand tracing from Bushong and Malekula from Vanuatu to illustrate graph theory, Inca strip patterns and Maori rafter patterns representing traditional geometry, and the Iroquoi games to illustrate the traditional understanding of chance. In addition, Barton and Fairhall (1995) studied and identified the mathematics from Maori designs, patterns and carvings. Similarly, Lean (1994) studied and identified more than 800 counting systems of Papua New Guinea and the Oceana region. Muke (2001) extended Lean's work and examined counting practices in Mid-*Wahgi* culture of Jiwaka Province in Papua New Guinea.

However, the most significant study was from Bishop (1988). In trying to give a theoretical underpinning for Ethnomathematics, he identified six universal cultural activities that had potential to involve mathematical ideas. According to Bishop (1988), these universal activities were: *counting*, *locating*, *measuring*, *designing*, *playing* and *explaining*. Kaleva (2001), in relating Bishop's six categories to topics normally taught in school mathematics, suggested *counting* could form the basis for number systems, algebraic representation and probabilities; *locating* could form the basis for orientation, coordination, bearings, angles and loci; *measuring* could form the basis for comparing, ordering, measurements and approximations; *designing* could form the basis for projections of objects/shapes, geometric shapes and ratio; *playing* could form the basis for puzzles, paradoxes, models, games and hypothetical reasoning; and *explaining* could form the basis for classification, convention, generalizations and symbol explanation.

In the earlier section (2.2.2), it was shown that languages presumably developed with their embedded cultural knowledge, and differences between languages in part reflect the different social and physical needs of the various cultures. Ethnomathematics has shown that different mathematical knowledge is embedded in respective languages. But in today's world such cultures, languages and the associated mathematical ideas rarely exist in isolation. People with different cultures and languages do meet for many purposes. In particular, children and teachers from different language backgrounds make up bilingual or multilingual classrooms, which in fact is the most common classroom context in the world. This is dealt with explicitly in the next section.

2.2.4 Bilingual and Multilingual Classrooms

Speaking more than one or two languages has been important for many people living in bi/multilingual societies throughout the world. Such knowledge helps them to break language barriers to communicate, trade, and resolve problems that were life-determining (Wardhaugh, 1998). Most such societies, including those in developing countries such as Papua New Guinea, accepted a western schooling system for their children, and this meant that the teachers in schools worked in classrooms that were bilingual or multilingual (Clarkson, 2004). The language contexts in mathematics classrooms vary enormously. The crucial factors in the variation are the different languages of communication that are present. The possible sources of such language variation in a schooling situation include the student's language(s), the teacher's language(s), and the official language of instruction (Clarkson, 2004). There are various combinations of these factors which give rise to different language contexts in classrooms. For example in some cities in the United States, English is the language of minority in the classroom with most Latino students speakers of Spanish (Moschkovich, 2002). However, in the United Kingdom and Australia, English is the language of the majority, but there are also a minority of students who are speakers of other languages because of their migrant backgrounds (Barwell, 2008). In other cases, the main language of almost all learners in the classroom is different from the official language of instruction. Such a language environment is found in South Africa (Adler, 1996; Saunders, 1988; Setati, 2003; M. Setati, 2005; Setati & Adler, 2001). This last language environment is similar to that of Papua New Guinea as described in later chapters of this study.

When more than one language is used in a single conversation, the language practice of code-switching naturally takes place. To be bilingual or multilingual means not only to learn each language, but also the skills of how and when to shift between languages to enable effective communication. The major focus of this study is related to the skills of effective use of each language in code-switching to teach (or learn) school mathematical ideas. The details of using language in code-switching for learning and teaching is discussed in sections 2.4 and 2.5 respectively, but in the following section a brief background of such language practice is explored.

2.2.5 The Language Practice of Code-Switching

According to Skiba (1997) and Wardhaugh (1998) 'code-switching' is a term in linguistics referring to using more than one language or dialect in a single conversation. Bilinguals, who can speak at least two languages fluently, also develop the skills to shift between languages, using elements of both languages when conversing with another bilingual. As Skiba (1997) indicated, in most cases what is said is syntactically and phonologically appropriate; that means that even if words from another language are included in a sentence, they would be adapted to the grammatical rules of the first language. There are two identifiable characteristic of code-switching. According to Skiba (1997), firstly, code-switching occurs between sentences (inter sentential) or, secondly within a single sentence (intra sentential). Code-switching that occurs between sentences (inter sentential), could occur after a single sentence or number of sentences. The purpose of such switching varies, but according to Setati and Adler (2001), it includes repeating, paraphrasing, explaining etc., which all help with ensuring the conversation is understood by both speakers. Similarly, code-switching that occurs within a sentence (intra sentential) involves two patterns. According to Setati and Adler (2001), if the practice involves a single word, this is described as code-borrowing, but when a number of words are switched, this is referred to as code-mixing. The most common reason for a language to borrow words or number of words includes the absence of such terms, or such terms that are known by the speakers, and its embedded meaning in that language. Hence the core purpose of code-switching, no matter which type is used, is to try and ensure the clarity of shared meaning between the people speaking.

2.2.6 Summary

Section 2.2 has provided a general but sufficient background of the relationship between culture, language and mathematical knowledge (ideas) and how they combine to affect the use of language for instructional purposes. Two factors were highlighted. Firstly, it was noted that the development of language and knowledge, including mathematical ideas occurs in all cultures, but because of the different requirements of cultures, there were differences in languages and mathematics. Ethnomathematical research has confirmed that mathematical ideas from traditional cultures exist and are embedded in their respective languages. Due to the difference in social and physical demands, these mathematical ideas vary between different cultures. When people from different cultural backgrounds meet including in classrooms situations to learn and teach school mathematical ideas, the resulting multilingual and bilingual context is challenging. Secondly, in situations where people from different language backgrounds do meet but who share common languages, the natural language practice of code-switching is often used to ensure effective communication. This language practices eases the challenges of using two languages with different backgrounds in a single conversation. The researcher returns to discuss this practice in the classroom in sections 2.4 and 2.5.

Mathematics has its specific language register and discourse (Pimm, 1987). Teachers and learners face the challenge of using such mathematical language correctly and effectively, despite differences in languages, cultures and mathematical ideas. The following section outlines language demands for instruction in a mathematics classroom.

2.3 Language Impact on Mathematics Teaching and Learning

Mathematics has a curious relationship with language. For some researchers, mathematics is a language (Mousley & Marks, 1991); for others mathematics is beyond language, a mode of thinking that escapes the ambiguous meanings of human beings or the languages they used (Barwell, 2008; Halliday, 1978). Those who proposed that mathematics is a language argue that both language and mathematics were semiotic systems: systems of meanings and systems for constructing meaning (Chapman, 1993; Mousley & Marks, 1991). In addition, both language and mathematics are resource systems for the creation of meanings. However, it was perhaps easier to view language rather than mathematics in this way. According to Barwell (2008), there was a recognition that mathematics involved a distinctive form of language use, but it is not really a language. Thus there is a specific way of using language for mathematical purposes. One way of describing the relationship between mathematics and language is in terms of the linguistic notion of register.

2.3.1 Mathematics Register

One way of distinguishing mathematics with respect to language is to consider the definition of the 'mathematics register' (Pimm, 1991). As Halliday (1978) defined it;

> The mathematics register was a set of meanings that belong to the language of mathematics (the mathematical use of natural language) and that a language must express if it was used for mathematical purposes. We should not think of a mathematical register as constituted solely of terminology, or of the development of a register as simply a process of adding new words. (p.76)

As Barwell (2008) commented, this definition maintained a separation between language and mathematics, or rather, between linguistic meaning and mathematical meaning. In other words, mathematics was not a language, but comprised meaning which could be expressed through one of a number of natural languages such as English, Greek, French or even local native languages if possible. Hence, part of learning mathematics was acquiring control over the mathematics register, which includes words, phrases, symbols, abbreviations, and ways of speaking, reading, writing and arguing, that are specific to mathematics (Setati, 2005).

Halliday (1978) made a number of important observations about mathematics registers. First, all languages were equally capable of developing mathematics registers, although there were variations in the extent to which this had happened. As indicated in the study of traditional mathematical ideas under the field of Ethnomathematics (see section 2.2.3), it is possible for the local vernacular of a traditional society to develop a mathematics register associated with the six universal mathematical activities Bishop (1988) identified. Second, different languages, through their semantic structures, stress some meanings more than others. The mathematics registers of different languages, therefore, may stress different mathematical meanings. This means that students of mathematics in different languages, including traditional societies, may well develop a different awareness of a given aspect of mathematics. Such a development, Halliday continued, has an impact across language use, where another language is used to express concepts developed with another language. Third, mathematics was a social activity and was therefore suffused with the values and patterns embedded in a natural language. It was not possible to eliminate language and associated cultural values from mathematics.   Within this argument it clearly follows that there will be an impact on instruction in mathematical classrooms

Going back to the definition of mathematics register, two categories emerge that are important for the present study. Firstly, what is applicable for this discussion is a list of words or phrases, dedicated to mathematics, and secondly, the ways of speaking, reading, writing and arguing, using these words. In this case, we are particularly concerned with speaking for the purposes of instruction given by teachers. In the following section, the researcher briefly explores each of these two areas. The researcher refers to earlier category as, ‘terms/phrases’ of the mathematics registers (sub section 2.3.2) and the later as ‘mathematical discourse’ (section 2.3.3).

2.3.2 Terms and Phrases of the Mathematics Register

As Chapman (1993) indicated, the school mathematics register is most readily identifiable in terms or phrases. Knowledge of such terms and phrases affects the language used for mathematical purpose, particularly in instruction. The terms and phrases could be from both traditional languages and English. However, most examples used below are from English, because research has yet to explore aspects related to many traditional languages. In this section, the researcher distinguishes four varieties of such terms/phrases.

The first includes the words that express meanings which are only mathematical such as ‘hypotenuse’ and ‘integer’ (Chapman, 1993). Such specific mathematical terms can be found in traditional languages, such as those that Lean (1994) identified for number names dedicated to different numbers from more than 1000 languages of the Oceania region. This included numbers 1 to 10 from the Wahgi language. As Muke (2001) described the terms *endi*, *tak* and the phrase *angek yem*, were dedicated to numbers 1, 2, and 5 in Wahgi language. These numbers were combined to form other numbers such as; 3, 4, 6, 7, 8, 9 and 10. For example, according to Muke (2001), numbers 3 was *takendika* (2 + 1), 4 *taksi taksi* (2 + 2), 6 *angek yem si endi* (5 + 1), 7 *agnek yem si tak* (5 + 2), 8 *angek yem si takendika* (5 + 2 + 1), 9 *angek yem si taksi taksi* (5 + 2 + 2) and 10 *angek yem yem* (5 + 5). Other mathematical terms in Wahgi include; measurement-size: *okma* (big), *kembis* (small); weight: *wudom* (light), *ombin-enem* (heavy), length: *holuang* (long), *singam* (short); time: phi (today), *tamaning* (yesterday), *tukpa* (tomorrow), *kupiro* (morning), *powdom* (afternoon), directions: *mi* (north), *ep* (south), *ak* (east) and *wuk* (west).

The second groups of words which are always challenging for learners are those that have double meanings. Such terms are challenging to use for mathematical purposes because students have to differentiate the meanings between those dedicated to mathematics and meanings that are non-mathematical. Such a situation could be found in almost all languages including traditional languages. To illustrate, there are numerous examples of the mathematical use of everyday English's words that have double meanings, where one of them is dedicated to mathematics. These terms include the following (see also Chapman, 1993);

result	prove	establish	simplify	negative	solution
identity	image	relation	universal	chord	face
index	multiple	network	intersection	mean	mode
operation	origin	multiple	plane	prime	range
variable	rationale	product	real	reciprocal	closed

The third category involves phrases or groupings of ordinary words that are recognized as mathematical technical terms in all languages, including traditional languages. The school mathematics register had an abundance of these in English such as:

degree of freedom	identity mapping	cumulative frequency
frequency	diagram direct route	prime factor
multiplicative	inverse /right angle	ordered pairs
highest	common factor/rounding off	empty set
square root	identity element	directed numbers

The fourth category of terms used to talk (write) mathematics is regarded as predicate logic in different languages. There could be examples from all languages, but in English this category includes items such as ‘and’, ‘or’, ‘if’, ‘then’, ‘some’, ‘any’, and so on (Setati and Adler, 2001). Their importance to mathematical learning has been long recognized (Dawe, 1983; Zepp, 1989), as has their lack of explicit teaching in mathematics (Clarkson, 2004). According to Setati (2001), these words are confusing when used in mathematical conversations (spoken or written), because they appear to belong to ordinary English when in fact they have been redefined for logical reasons. Hence in one way these fit into the second category above, but because of their importance they are noted here separately. The detailed description of such an argument is not the focus of this thesis, but details could be read in Pimm (1987) and Setati (2002).

The researcher has explored varieties of terms or phrases and their mathematical meanings which have an impact on instruction. The use of such terms and phrases in teaching mathematics is not the only process involved. It also includes the pattern and the ways these terms and phrases are used to talk mathematics that reflect the nature of subject. In other words, the ways of talking that belong only to mathematical ways of expression. The linguists refer to ways of talking for a specific purpose as ‘discourse’, and the researcher explores discourse in mathematics perspectives in the following section.

2.3.3 Mathematical Discourse

As the researcher has indicated earlier, mathematics registers are in part made up of specific words and symbolic structures that possess mathematical meanings. Words and symbols, however, do not stand alone when expressing meaning, but are strung together in sentences or paragraphs in language, either in spoken or written form. In this case, we are concerned with the spoken form used by teachers. For mathematicians, there are very specific ways of talking mathematics. To describe such ways of talking, linguists use the general term 'discourse', which describes different ways of talking with respect to specific contexts or situations. Gee (1999, p.131) defined the term as;

> A discourse is a socially accepted association among ways of using language, other symbolic expressions, and artifacts, of thinking, feeling, believing, valuing and acting that can be used to identify oneself as a member of a socially meaningful group or 'social network', or to signal (that one is playing) a socially meaningful role.

There are multiple groups or communities in which students live. For this study, the students' immediate community is their home community, itself situated in a traditional society that exists as a cultural group through their sharing of language, knowledge and so on. Hence, respective languages in the traditional societies that the students belong to were learned in their relevant context.

In Papua New Guinea this means children learn the discourses of hunting, gardening, fishing and so on, related to events that determine their life. Within each of these discourses, certain mathematical talking is embedded. The children learn such traditional discourses before they go to school. But at some point, children do go to school and hence enter a parallel community, that of the classroom. This new community requires specific ways of talking to allow meaningful participation in the group. But within the classroom situation, two sub-kinds of classroom discourse can take place simultaneously (see Figure 2.1). First there is the general classroom discourse, second a mathematical discourse and a non-mathematics discourse embedded in the general classroom discourse. The general classroom discourse that teachers use to guide learning will be discussed in section 2.5 of this chapter when aspects of teaching are discussed.

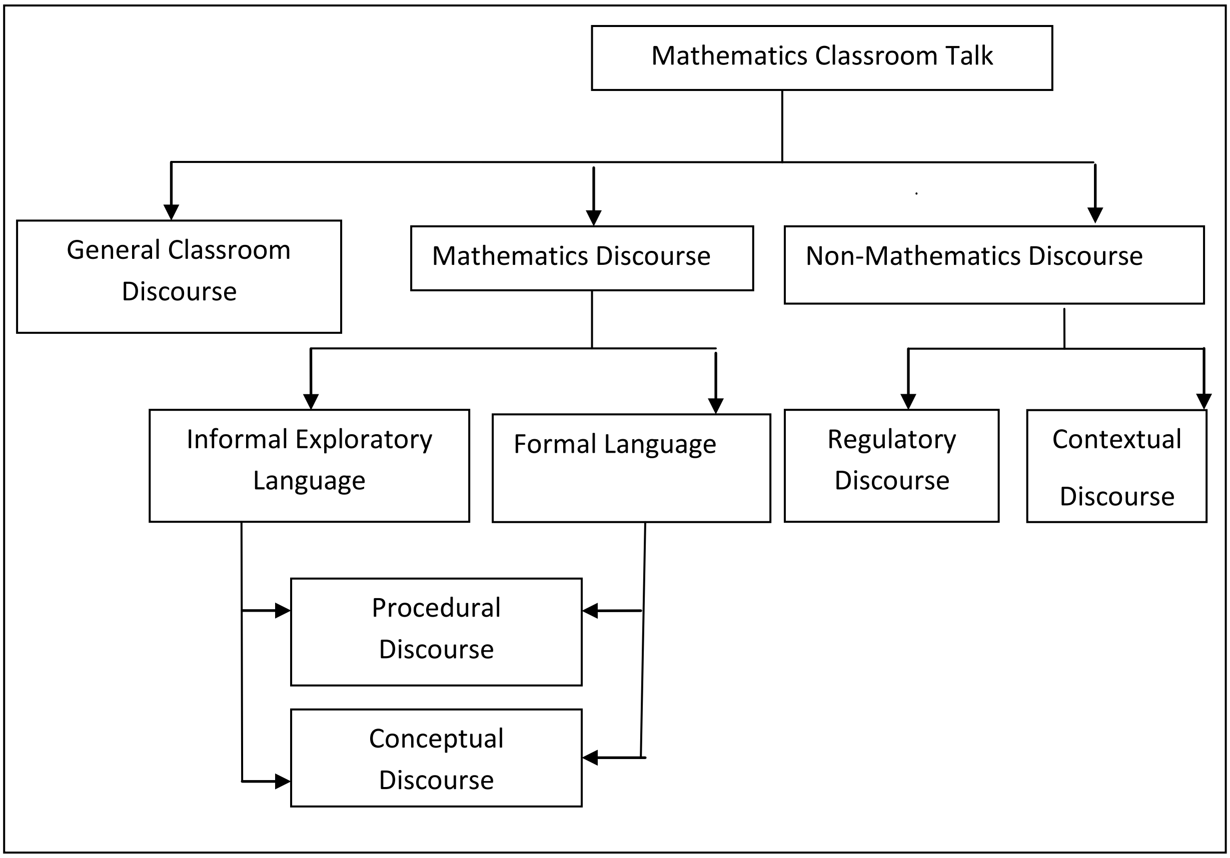

Figure 2.1. Public Discourses in Mathematics Classrooms initiated by the Teacher (see section 2.5 for discussion)

In a mathematics lesson, two types of mathematical discourse exist and are shown in Figure 2.1 (Moschkovich, 2002). The non-mathematical discourse involves regulatory and contextual discourse (see section 2.3.4). The mathematical discourse involves informal exploratory language and formal language (section 2.3.5). Each type of mathematical discourse can further be categorized as procedural and conceptual discourse (section 2.3.6).

It should be emphasized that, for a successful lesson, both non-mathematical and mathematical discourses are vital. The researcher investigates different ways of talking mathematics in the following sections, since the rest of the thesis is focused on this aspect of the classroom language environment. The researcher begins by exploring the non-mathematical talk, since it plays a part in contributing to a successful mathematics lesson.

2.3.4 Non-Mathematical Discourse – Regulatory and Contextual

Within a mathematics lesson, there is non-mathematical discourse at play. Even though it is not the focus of this study, it is important to acknowledge its existence because it plays a major role in any successful mathematical lesson. As indicated in Figure 2.1, in the study that Setati (2005) undertook, two types of discourse emerged within this category; regulatory and contextual discourse. According to Setati, regulatory discourse was mainly used by teachers, and referred to by them, in interactions that focus on regulating the learners' behavior. This discourse was mainly used to call for the learners' attention, to request them to listen to the teacher or to each other, or to get them ready for a specific task during the lesson. On the other hand, the contextual discourse focuses on the context of the mathematical task under discussion. Contextual discourse is common when dealing with word problems where the interaction is about the context of the word problem and not the mathematics per se of the problem. Although the context being discussed might be familiar; the ways in which they are discussed in mathematics classrooms is not the same as in everyday interactions. For example, the teacher often pretends that he/she does not know the context and expects the learners to unpack it with her/him.

2.3.5 Mathematical Discourse - Informal and Formal Language

In most mathematics classrooms, both formal and informal language is used, in either written or spoken form. To elaborate, most learners come into the school with informal ways of talking mathematics. The informal type of talk is the kind that learners use in their everyday lives to express their mathematical thinking (Setati, 2002; Setati & Adler, 2001). For example, learners in everyday life may well refer to a 'half' as any fraction of a whole and hence talk about dividing a whole into three 'halves' or ask "which is the bigger half?" Formal mathematical language refers to the standard use of terminology that is usually developed within formal settings like schools. Considering the above example of 'half', using formal mathematics language, it is inappropriate to talk about a whole being divided into three halves. If this is so, then the results would be 'thirds'. Similarly, in formal mathematical language, two halves must be equal, not one bigger than the other.

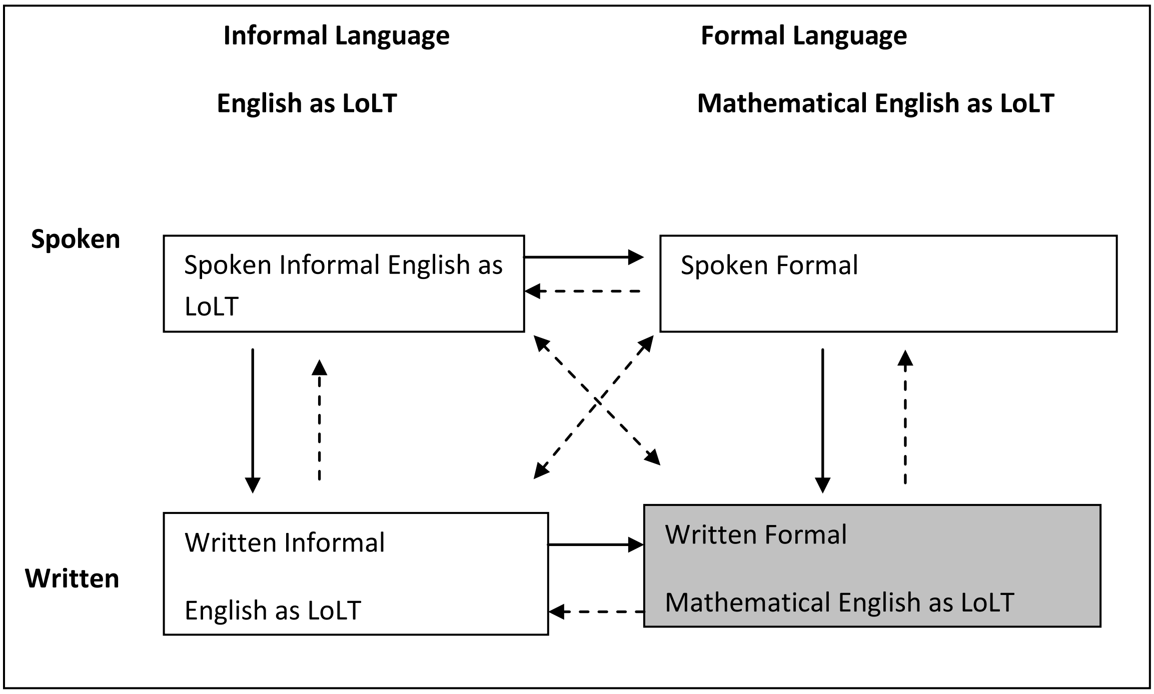

Figure 2.2. Possible routes of Informal and Formal Language using Mathematical English

[LoLT- means Language of Learning and Teaching, (Pimm, 1991)]

As Setati and Adler (2001) indicated, the valued goal in school mathematics classroom is formal, written mathematical English competence. To achieve this, Pimm (1991) suggested two possible routes to facilitate movement from informal spoken language to the formal written mathematical language. Using Figure 2.2, Pimm's preference was represented with whole lines, although other possibilities are shown with dotted arrows. The first route was to encourage learners to write down their informal utterances and then to work on making the written language more self-sufficient. The second was to work on the formality and self-sufficiency of the spoken language prior to its being written down (Setati & Adler, 2001). Within such ways of using language in talking (or writing), according to Setati (2005), there exists two more categories and they are discussed below as procedural and conceptual discourses.

2.3.6 Mathematical Discourse - Procedural and Conceptual Discourse

Procedural discourse focuses on the steps (often steps in a calculation) taken to solve a problem. This discourse has a computational orientation in teaching, where mathematics is viewed as composed of procedural steps, and doing mathematics is computing or following a set of procedures in the absence of any reason for the computation (Setati, 2005). On the other hand, conceptual discourse, according to Setati, is the discourse in which the reasons for calculating in particular ways and using particular procedures to solve a mathematical problem become explicit topics of conversation. In conceptual discourse, learners articulate, share, discuss, reflect upon, and refine their understanding of the mathematics that is the focus of the interaction. It is the responsibility of the teacher to create a classroom environment in which both of these kinds of interactions are possible; that is classroom situations where conceptual discourse is not only encouraged but valued (Adler, 1996; Moschkovich, 2002; Setati, 2003; 2005; Sfard, Nesher, Streefland, Cobb & Mason, 1998). To be able to communicate mathematically, a learner needs to be able to engage in both procedural and conceptual discourse.

So far the researcher has discussed issues related to using language for mathematical purposes. This will be read as implying the use of a single language of mathematical discourse. Given the earlier discussion, this could be a traditional language or English. However, in most mathematics classrooms in the world, there is more than one language in use. In most cases the mix is composed of one or more traditional languages and a different teaching language, which in this study is English. The teaching language is nearly always specified by government policies. This creates a bi/multilingual mathematical classroom, and the ways of talking mathematics become very complex. Such a situation has an impact on instruction and the following section describes the complex network of language-use for mathematical purposes in teaching (or learning) in a bi/multilingual environment.

2.3.7 Mathematical Discourse in Bi-/Multilingual Classrooms

The situation at the centre of this study is the use of more than one language to teach mathematics, and the impact this has on mathematical discourse within classroom instructions. The research findings of how languages are used for learning and teaching are described in depth in sections 2.4 and 2.5 respectively. However, this sub-section describes the complex networks involved in the use of more than one language for mathematical purposes. To illustrate, in Papua New Guinea, English, a foreign language, is expected to be used as the Language of Learning and Teaching (LoLT). Clearly, in such a situation, there is an interaction between a learner's main language, their home language or vernacular, and the language of instruction (English). But the interactions are complex. As has been already outlined, any language can be analysed into a variety of components (see Figure 2.2). Hence in Papua New Guinea classrooms there will be multiple interactions between components of the students' language and English. Some of these are shown in Figure 2.3. Setati and Alder's (2001) observations presented in Figure 2.3 show five different routes of interactions between the main language and English as LoLT when spoken and written languages were considered. Since the situation of South Africa is quite similar to that of Papua New Guinea, the analogous content between these countries are considered in more depth in chapter 3.

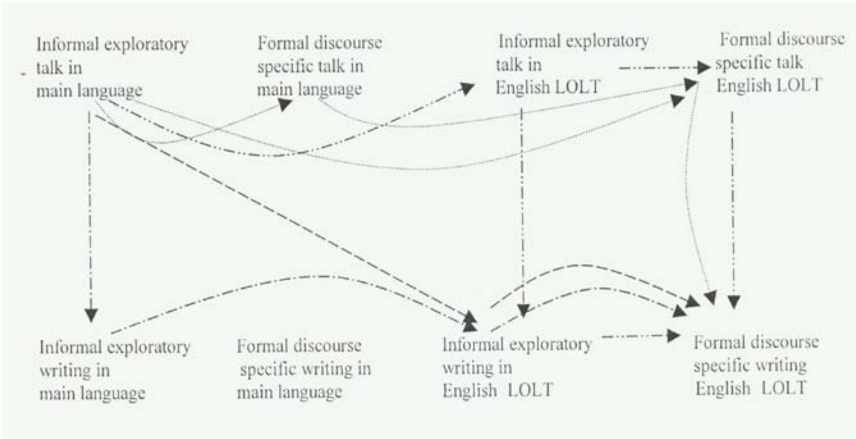

Figure 2.3. Route of informal and formal Language use in Bi-/Multilingual Classroom

(adopted from Setati & Adler, 2002, p.250).

2.3.8 South African Language Policy and Research

So far in this section, I have reviewed areas which could affect language use in teaching mathematics. One of the areas that affect instruction is the use of more than one language in bi/multilingual mathematics classroom and the network of such language-use. A language environment in most cases is influenced by government policy, particularly when a foreign language is the mandated LOLT. Such a situation is found in Papua New Guinea. One of the purposes of this study is to assess the implementation of this policy. There are such policy demands set by many governments of the world, but the one that is very similar to Papua New Guinea is from South Africa. Their language policy, language environment and practice in classrooms and research findings from such language background, formed a major part of this literature review, particularly related to code-switching (see section 2.4.3). Therefore, it is appropriate to briefly describe specifically the language policy, language environment and languages practice in South African mathematics classrooms.

The South African language policy, which has encouraged the use of other languages as well as English, has consequently promoted the language practice of code-switching in South African classroom. This policy came into effect after the African National Congress (ANC) party was voted into power in 1996. As Setati (2002) indicated, when the ANC was voted into power, multiple policy initiatives began across all social services, including the language policies, a process that fully recognized the rich multilingual nature of South Africa. The constitution adopted in 1996 for post-apartheid South Africa recognized 11 official languages. For the first time, nine African languages: Sesotho, Sepedi, Setswana, Tshivenda, Xitsonga, IsiNdebele, IsiXhosa, IsiSwati and IsiZulu, received official status, in addition to English and Afrikaans.

Already in December 1995 the Minister of Arts, Culture, Science and Technology announced the establishment of a Language Plan Task Group (LANGTAG). Its role was to identify South Africa's language-related needs and priorities. Since then, LANGTAG has articulated a multilingual policy for South Africa. It proposed a widespread use of the nine main African languages in all spheres. This proposal was challenged by some members of the Division of Applied English Language Studies at the University of the Witwatersrand. They believed that the widespread use of the nine African languages would not necessarily alter the status and power of English, while at the same time ensuring redress for African languages. They maintained that this redress would enable teachers to teach English as a subject without guilt to help learners understand that all languages were valuable and were a national treasure (Setati, 2002). According to Setati, the issue of the dominance of English in South Africa has not been easy to resolve.

According to this policy, not only could South African schools and learners choose their Language of Learning and Teaching (LoLT), but there was a policy environment that supported the use of multiple languages in a given school. Hence language practices like code-switching were supported. While this new policy-in-education was widely acknowledged as ‘good’, it was already meeting significant on-the-ground constraints (Setati, 2002). Research suggested that most schools were not opting to use their learners’ main language as LoLT in both policy and practice (Setati, 2002). While the new language policy in South Africa was intended to address the over-valuing of English and Afrikaans and the undervaluing of African languages, in practice English continued to dominate. Even though English was a main language of a minority, it was both the language of power and language of educational and socio-economic advancement. Thus it was a dominant symbolic resource in the linguistic market in South Africa (Setati, 2002). The linguistic market was embodied by and enacted in the many key situations (e.g., educational settings, job situations) in which symbolic resources, like certain types of linguistic skills, were demanded of social actors if they wanted to gain access to valuable social, educational, and eventually material resources (Bourdieu, 1991 cited in Setati 2002).

Irrespective of the expressed language policy, various institutional arrangements and government policies in South Africa continued to support the dominance of English in the linguistic market. First, LoLT in higher education was in English. Second, there was an English/Afrikaans-language pre-requisite for anyone to become professional in South Africa. Third, there were still policies upholding English as an official legal and government language, in which most policy documents were written. Fourth, there was the imposition of an English requirement for individuals aspiring to join the civil service. The fact remained that English was the most important criterion for selection of high-ranking officials; knowledge of an African language was seen as an additional asset but not an essential one (Setati, 2002). With these institutional practices and policies well-entrenched in the various administrative, educational, and professional arenas of South Africa, a symbolic market had been formed where English constituted the dominant, if not exclusive, symbolic resource. It was a prerequisite for individuals aspiring to gain a share of the socio-economic, material resources enjoyed by an elite group.

The politics of changing language policies had an impact on mathematical teaching and learning practices, particularly in the many multilingual classrooms. In 1995 the Minister of Education announced the introduction of a new curriculum. According to Setati (2002), in March 1997, this curriculum was launched and became known as Curriculum 2005. According to Curriculum 2005, a minimum of two languages should be used; however, there was no prescription as to what these languages should be. According to the curriculum's official document, multilingualism was recognized as a valuable resource (Setati, 2002). A focus on an integrated and non-disciplinary division of knowledge in Curriculum 2005 led to an introduction of eight learning areas that replaced school subjects. The understanding was that learning areas would promote strong integration of what was learned, both academically and in everyday life (Setati, 2002). The official description of the mathematics learning was that:

> Mathematics was the construction of knowledge that dealt with qualitative and quantitative relationships of space and time. It was a human activity that dealt with patterns, problem solving, logical thinking etc., in an attempt to understand the world and make sense of that understanding. This understanding was expressed, developed and contested through language symbols and social interactions. (Setati, 2002)

The above description emphasized the role language played in the expression, development and contestation of mathematics. This view highlighted languages as a tool for communication, thinking and politics in mathematics classrooms in South Africa. The role of language in mathematics was also highlighted in the specific outcomes of mathematics learning. Outcome 9, according to Setati (2002), stated that learners should be able to use mathematical language to communicate mathematical ideas, concepts, generalizations and thought process. Curriculum 2005 was reviewed during the year 2000 and a task team was appointed to develop a national-curriculum statement for mathematics. Language and communication was again emphasized in the national curriculum statements. According to Setati (2002), Learning Outcome 2 that focused on patterns, functions and algebra stated that learners should be able to recognize, describe and represent patterns and relationships, and solve problems using algebraic language and skills (Setati, 2002).

The policy environment in South Africa has stimulated a number of language-environment and language practices. This in turn has encouraged much research, which will be returned to in Chapters 4, 5 and 6 of this thesis.

2.4 Learning

As indicated in Chapter 1 and earlier in this chapter, the major focus of this study is related to language(s) use in the teaching process. However, this does not mean that learning can be ignored. In fact, the end result targeted within the effective use of language in the teaching process is learning. Therefore, this section will discuss how language(s) and teaching processes, separately or combined have an impact on learning. In order to do this, this section considers two learning theories and their associated research findings that explain and confirm the relationship between the use of language(s), teaching processes and learning. They are social-constructivist theory and the cognitive theory of bilingualism, each of which is dealt with in later sections. The discussion in this section is mainly related to learning in a bi/multilingual classroom. In particular the language practice of code-switching will be explored as a resource used by students for learning effectively. By exploring the relationship between language-use and code-switching in the mathematical classroom, instructions maybe enhanced. The researcher begins with the social constructivist theory and explores the general relationship between teaching process and language, and then their combined effect on learning.

2.4.1 Social-Constructivist Theory

In this section social-constructivist views on learning are explored. This theory was selected from others because it deals in depth with the relationship between cognition and social influence on learning. In addition, this theory has heavily influenced curriculum development in Papua New Guinea. The particular social influence at the centre of this study is the way language is used in the teaching process. In other words, through this theory the importance of language-use within the teaching process and how this can enhance learning is explored. Language does contribute to learning independently. But the focus of this study is the combined effect of using language and the teaching process on learning.

To begin, social-constructivism is based on specific assumptions about learning. To understand and apply models of instruction that are rooted in the perspectives of social constructivism, it is important to know the premises in which it is grounded. Social constructivists viewed learning as a social process (Bruner, 1990; Vygotsky, 1978). Learning does not take place only within an individual, nor is it a passive development of behaviors that is shaped by external forces. Meaningful learning occurs when individuals are engaged in social activities. Social-constructivists discuss two aspects of social context that largely affect the nature and extent of learning. They are the social interaction between knowledgeable others, and the impacts of cultural symbol systems. The researcher describes each of these aspects in the following sections.

2.4.1.1 The Effects of Social Interactions on Learning

In order to understand social-constructivist perspectives through the effects of social interaction on learning, one must understand the two principles Vygotsky (1978) proposed. These are the more knowledgeable others (MKO) and the Zone of Proximal Development (ZPD) (Dahms, Geonnotti, Schilk, Wetzel & Zulkowsky, 2007; Vygotsky, 1962, 1978). Vygotsky (1978) defined those who were to teach as the ‘More Knowledgeable Others’ (MKO). Dahms et al (2007) noted that Vygotsky used MKO for anyone who had a better understanding or a higher ability level than the learner, particularly in regard to a specific task, concept or process. Traditionally the MKO was thought of as a teacher or an adult. However, this was not always the case. Other possibilities for an MKO could be a peer, sibling, a young person, or even a computer. The key to being an MKO was that they must have more knowledge about the topic being learnt than the learner does. Among other mediums, language was a vital tool used by the MKO to enhance his or her role. However, an MKO was needed only during a specific time of the learning situation. According to

Vygotsky (1978), the crucial time when learners needed sensitive guidance and encouragement from an MKO was when a ‘Zone of Proximal Development’ (ZPD) exists.

The ‘Zone of Proximal Development’ was an important concept that related to the difference between what a learner could achieve independently and what more a learner could achieve with guidance and encouragement from a skilled partner that is an MKO. Vygotsky (1978) saw the ‘Zone of Proximal Development’ as the area where the most sensitive instruction or guidance could be given, allowing the learner to develop skills and/or concepts they will then use independently. Brunner (1993) extended Vygotsky’s work, particularly in respect to the methods of teaching within the ZPD in a classroom situation. According to Brunner (1983), the ideal role of the teacher (the MKO in this context) was that of providing scaffolding (for example, collaborative dialogue) to assist students on learning tasks. There were a number of steps within the process of scaffolding. As Dahms *et al* (2007) described Brunner’s techniques involved in scaffolding, the first step was to build interest and engage the learner. Once the learner was actively participating, the given task should be simplified by breaking it into smaller subtasks. During this step, the teacher needed to keep the learner focused, while concentrating on the most important ideas of the task. One of the most integral steps in scaffolding consisted of keeping the learners from becoming frustrated (Bruner, 1986, 1990, 1996; Dahms et al., 2007). The final step associated with scaffolding involved the teacher modeling possible ways of completing the task, which the learner could then imitate and eventually internalize as a starter. During this process, learners would be encouraged to express their creativity and personalize methods for solving the problem. An important aspect of scaffolding was that there was a gradual withdrawal of support as the child’s knowledge and confidence increased (Bruner, 1996; Vygotsky, 1978). Vygotsky (1978) believed that when a student and teacher were in the ZPD for a particular task, providing the appropriate assistance (scaffolding) would give the student enough of a “boost” to achieve the task. Once the student, with the benefit of scaffolding, mastered the task, the scaffolding could then be removed, and the student should then be able to complete the task again on his/her own. Part of the technique of scaffolding used in the ZPD by the MKO to enhance learning, was clearly language in virtually all cases.

Vygotsky (1978) also commented on the social context. He suggested that a more competent learner (an MKO) is paired with a less competent one, so that the former can elevate the latter's competence. He viewed the interactions between such peers as an effective way of developing skills and strategies. In a classroom situation, he suggested that teachers use cooperative learning exercises where less competent children would develop with help from more skillful peers if a ZPD could be allowed to develop. This social context promoted sustained achievement and cognitive growth for less competent students. But a ZPD did not just automatically develop because of such pairing of students. Students needed to work together to construct their learning: to teach each other, so to speak. In-class opportunities for collaboration on difficult problem-solving tasks had potential for a ZPD to develop. By interacting with more capable students, who could mediate transactions between the struggling students and the content, all students benefited. This process of peers helping one another did not only benefit the weak student, but the more knowledgeable peers gained proficiency in respective contextual discourse. In this case, a peer maybe regarded as more knowledgeable in mathematical content, but not necessarily in the discourse of mathematics.

It appears then that both the notions of MKO and ZPD have a number of implications for instructional purposes. There is the suggestion that the role of MKO as a facilitator and it involves the MKO providing guidance and encouragement within a ZPD, while the learners take the lead in their own learning. There is also an implication that teachers should promote instruction that will engage children in collaborative learning, where free talking should occur between the teacher and student, and student and student. Such an instruction model depends heavily on communication processes (Mercer, 1995).

Although the notion of MKO and ZPD are well known core ideas for constructivism, Vygotsky recognized that any discourse, for example mathematical discourse, also relied on various cultural symbols. The researcher now turns to a brief discussion of these.

2.4.1.2 Cultural Symbol Systems – Effects of Cultural Knowledge on Learning

The major focus of this study is on language, but as indicated in section 2.2.2, since cultural knowledge and language are developed together, how effectively a language is used in some ways depends on established cultural knowledge, in which mathematical ideas are a part. The combined effect of cultural knowledge embedded in language will be discussed in later section, but in this section the socia-constructivist's view about the impacts of cultural or home knowledge on learning is discussed.

The details of how knowledge that eventually becomes part of a culture is developed is not the focus of this section. But the impact of what is already established as part of the culture, and inherited by a student, is the primary concern of this discussion. Put briefly, culture is established as the result of interaction between the social and physical world of people, to meet their desires for survival and for making sense of the world they live in. An experience and/or practice that is beneficial to human survival, or that helps make sense of the world they live in is later shared, and when accepted by all members of a group, these eventually become what is recognized as culture. Vygotsky (1978) suggested that humans are not born with knowledge, nor is knowledge independent of social context. Rather, one gains knowledge as one develops by way of social interactions with one's environment, including one's peers and adults. Embedded within such knowledge, mathematical ideas are present. In an earlier section (2.2.3), through the field of Ethnomathematics, traditional mathematical ideas were identified to confirm their existence, and such knowledge is inevitably inherited by students and brought into their classrooms. Such prior knowledge plays a role in determining how and what is learnt in school mathematics.

There are a good number of studies that have been carried out with respect to assessing benefits of using non-western mathematical ideas or home mathematical ideas that are not normally included in teaching school mathematics (Barton, 1996; Barton & Fairhall, 1995; Bishop, 1988; D'Ambrosio, 1997). The researcher will not describe all aspects of these studies. However, to illustrate, the researcher briefly considers some benefits of including mathematical ideas from students' backgrounds.

As Vygotsky (1962) and Brunner (1990) indicated, a very important precursor to how and what is learnt in school is the prior knowledge of the learners. Part of the students' prior knowledge will be the traditional mathematical ideas learned before they attend school, and incidentally they continue to learn in their communities outside of school when of school age. Such prior knowledge is learned in familiar settings which are dilemma-driven or goal-directed. Explanations are given in the learners' own languages, and occur often in apprenticeship situations allowing for observations of the skill and thinking involved by expert performers (Bishop, 1991a, 1991b; Masingila, 1993). Such instruction provides a meaningful, practical and purposeful learning. In other words, this type of instruction provides enough stimuli and motivation for an effective cognition process that normally results in successful learning. In contrast, in most mathematics classrooms, there is a lack of such a technique of instruction, and abstract learning rather than skills-training is more frequently the hoped-for outcome. As Masingila (1993) noted, school mathematics instructions places a lot of emphasis on transmission of syntax (procedures) rather than on the teaching of semantics (meaning), and this has discouraged children's intuitions to grow. If meaningful and purposeful presentation of context categorized as prior knowledge is a key component for learners in what and how to learn (Bruner, 1990; Vygotsky, 1962), the inclusion of traditional mathematical ideas or home mathematical ideas and related contexts may well be part of such an approach. As Bishop (1991b) and D'Ambrosio (1997) noted, in order to make school mathematics meaningful and purposeful for children who were from varying cultural backgrounds, there must be a connection made in mathematical classrooms to their prior home knowledge, including traditional mathematical ideas. A lack of such an approach will not only hinder learning, but will also discourage students in their future learning and also foster their perception that mathematics was a hard subject. To promote school mathematics, the way forward, they suggest, is to include traditional mathematical ideas and their related contexts, while still teaching and learning school mathematics. How to create such contexts may well vary, but the principle is clear enough. The next chapter will comment on how the Papua New Guinea curriculum has progressed down this path.

This section described the socialconstructivist view that cultural knowledge, or knowledge from students' background, plays an important role as prior knowledge, influencing what and how a student learns. For effective instruction, such knowledge should be acknowledged and included in teaching, to enhance meaningful learning. The second cultural symbol system that affects learning is language, and the following section will explore the social constructivist view related to language.

2.4.1.3 Cultural Symbol Systems - Effects of Language on Learning

This sub-section describes the social-constructivist perspectives related to language and learning. From a social-constructivist view point, language performs two critical roles. First, as Mercer (1995) noted, language offers a vital means by which learners represent their own thought to themselves. Vygotsky (1978) described language as a psychological tool, something each of us uses to make sense of experience. Second, language is also the learners' essential cultural tool, used to share experience and so collectively, jointly, make sense of it (Bruner, 1990, 1996; Dahms et al., 2007; Vygotsky, 1978). Thus language is a means for transforming experience into cultural knowledge and understanding. This latter role of language is not only the main means used by learners to make sense of personal experience, it is also important for adults to use and guide learning (Dahms et al., 2007). In most cases, this occurs through communication processes that use language as the major medium.

Vygotsky (1962) argued that language was the tool for determining the ways a child learnt how to think, since complex concepts were conveyed to the child through words. Learning, according to Vygotsky (1962), always involved some type of external experience being transformed into internal processes mainly through the use of language. It followed that speech and language were the primary tools used to communicate with others, promoting learning. Moving from this general principle to the specific classroom process, learners use language to negotiate their understanding with the teacher. Language may be used by the learners independently in their self cognition processes, but language is also vitally important for communicating with adults or peers who are more knowledgeable (MKOs) and who can play a critical role in guiding and modeling the correct ways of expressing information and knowledge (ZPD), which learners internalize. Hence, language as a cultural symbol-system is an important medium of communication in the teaching process. It is straightforward to understand language in this way, if we refer to one language. However, it becomes more complex when language and cognition are discussed in the context of bi/multilingual learning. The following section will explore how learning in such a language environment might be enhanced.

2.4.2 Learning in Bi-/Multilingual Environment

As indicated earlier in section 2.2.4, speaking many languages has always been culturally important for many traditional societies for life-determining activities. But teaching new knowledge in a new language in a classroom situation is challenging for children and very different from traditional processes. For students from a traditional society, not to be able to access known language and other cultural symbols in a western-style class is challenging. Over many decades, there has been an ongoing debate centered on the relationship between bi/multilingualism and learning. It is not necessary here to trace this debate in detail. It is sufficient to note that some researchers have maintained that multilingualism has had a negative impact on language development, educational attainment, cognitive growth and intelligence (Setati & Adler, 2001). Others have argued that, under certain conditions, multilingual skills have a positive effect on the learning process (Baker, 1993; Cummins, 1981a, 1984; Cummins & Merrill, 1986). In the case of mathematics, the relationship between multilingual and mathematics learning has long been recognized. Dawe (1983), Clarkson (1991), Zepp (1989) and Clarkson and Thomas (1993) have all argued that multilingualism did not necessarily impede mathematics learning. These studies have drawn extensively on Cummins' (1981a) work on the relationship between language and cognition. Baker (2006) described Cummin's work as the 'cognition theory of bilingualism'. Cummins' theory provides a starting point for explaining how, at certain stages of language proficiencies, the languages of multilingual speakers have an impact on successful learning. In order to identify such stages and distinguish their advantages and disadvantages, the researcher explores two hypotheses that form the basis of this theory. As Clarkson (1991) noted, the first was called the 'threshold hypothesis' and the second was called 'developmental independent hypothesis'(Baker, 2006; Clarkson, 1991; Cummins & Merrill, 1986). The researcher describes both hypotheses in the following sections.

2.4.2.1 Threshold Hypothesis

The threshold hypothesis of Cummins centered on the idea of 'balanced bilingualism' (Baker, 2006; Clarkson, 1991) and proposed two thresholds. According to Baker (2006), the lower threshold was the level a child had to reach to avoid the negative consequences of bilingualism, and the upper threshold was a level above which a child would experience the possible positive benefits of bilingualism. The threshold hypothesis may be portrayed in terms of a house with three floors (see Figure 2.4). According to Baker (2006), on the sides of the house are placed with two language ladders, indicating that a bilingual child will usually be moving upward (or downward) and will not be stationary on a floor.

In Figure 2.4 three language environments associated with these thresholds are described: on the bottom floor of the house are those whose current competence in both their languages is insufficiently or relatively inadequately developed, especially compared with their age group. When there is a low level of competence in both languages, there may be negative or detrimental cognitive effects. A child who is unable to cope in the classroom in either language may suffer educationally. In most cases in such situation, as Clarkson (1991) described it, first language (L1) which is the home language, was normally being replaced by the second language (L2) which is the official language of instruction. Cummins (1981b) described this language environment as 'subtractive'.

At the middle level, the second floor of the house is occupied by those with age-appropriate competence in one of their languages, but not both. At this level, a bilingual child will be little different in cognition from the monolingual child and is unlikely to have any significant positive or negative differences compared with a monolingual. Hence these are children who can operate competently in the classroom with one of their languages, but not in their second language. This is the case where someone was learning an additional language to a language he/she spoke fluently already (Clarkson, 1991). In most cases, such a language environment is found where the language of instruction is different to home or playground language, but little effort is made to ensure the competency of the first language is grown to deal with school ideas. Baker (2006) suggested that in this environment, there was a neutral effect on learning. According to Cummins (1981b), children in such language situation may eventually develop linguistically into ‘balanced bilinguals’, but this may take a longer than children above the upper threshold.

At the top of the house, the third floor, reside children who have age-appropriate ability in both their languages. It is at this level that the positive cognitive advantages of bilingualism appear, and these children enjoy cognitive advantages over monolinguals, being able to cope with curriculum material in either of their languages. However, as noted earlier, since students’ use of their languages is always in flux, most if not all students are on the ladders of Figure 2.4, not on the floors.

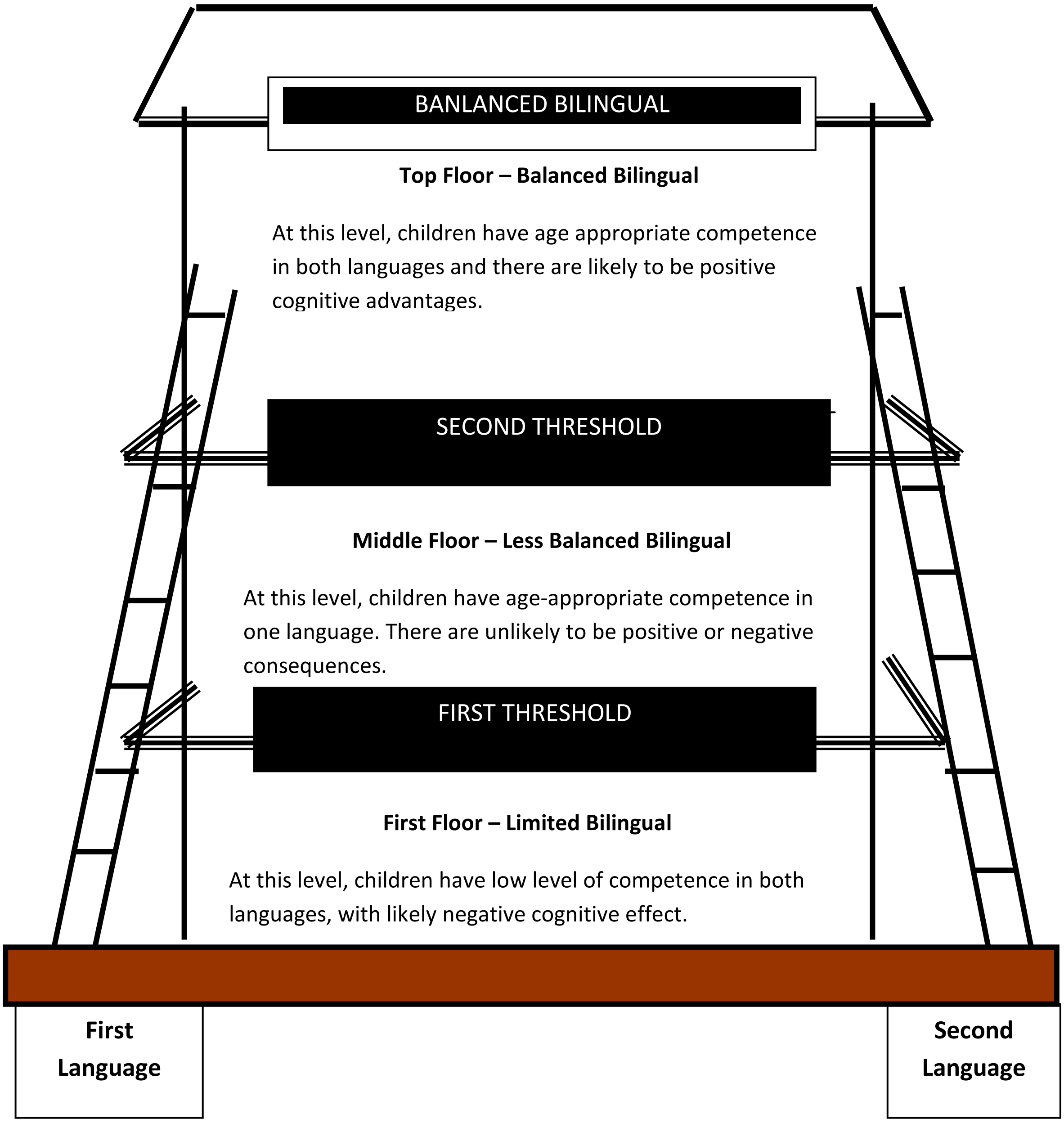

Figure 2.4. Different levels of Fluency by a Bilingual (Adopted from Baker, 2006, p. 172)

However, this theory by itself does not explain the relationship between the two languages (L1 and L2) and their impact on learning in detail. As Clarkson (1991) described it, this theory on its own suggested that the two languages in one sense operated separately, but had a combined effect on cognition. In Cummins' (1986) view, there was some form of reaction that took place between L1 and L2, which has a combined effect on cognition. Such a view was explored in the second hypothesis of Cummins called the 'developmental interdependent hypothesis'.

2.4.2.2 Developmental Interdependent Hypotheses

As Clarkson (1991) noted, whereas the threshold hypothesis tended to treat L1 and L2 separately but as having a combined effect on cognition, the second hypothesis suggested that L1 and L2 must also be seen as acting on each other. According to Cummins (1979 cited in Clarkson, 1991), both hypotheses must be taken together for a full description of the way languages of a bilingual student operated. This description suggested that a dual process was taking place simultaneously. The second hypothesis stated that when instruction took place in L2 there were two results : first the L1 played a role in developing L2, and second such instruction did not only develop skills of L2, but also helped in the development of L1 with deeper conceptual and linguistic proficiency and general academic skills (Clarkson, 1991).

For the first of these two processes, the hypothesis suggested that the level of competence in one language was partially the function of the student's competence in the other language (Cummins, 1979 cited in Clarkson, 1991). This meant the competency of L1, according to Baker (2006), played a major role in development of L2. This view of Cummins (1979 cited in Clarkson, 1991) was criticized for not precisely defining the level of language proficiency a child must have in L1 in order for an effective impact to be had on the development of L2. This criticism encouraged Cummins to outline the distinction between surface fluency of a language and more evolved language skills. Cummins (19984a, 1984b, 2000) expressed this distinction in terms of basic interpersonal communicative skills (BICS) and cognitive/academic language proficiency (CALP) (Baker, 2006). Furthermore, Cummins (2000a, 2000b) extended the instructional implications of CALP in terms of three components: cognitive, academic and language. As a further development to these three components of instruction, Cummins (2000) proposed two dimensions of communication. According to Baker (2006), they were cognitive demanding/undemanding communication and context embedded/reduced communication. According to Baker (2006), all these components and dimensions concerned communicative proficiency. Such proficiency in L1, in Cummins' (2000) view, would provide appropriate support in the development of L2.

However, the process whereby the proficiency of L1 influenced the development of L2 may be dependent on the two languages having similar histories of development and structures. As Barwell (2008) indicated, languages can develop differently. In part a language is dependent on physical and social environments. As already noted, languages will be developed by a community to meet social and environmental needs (Pimm, 1991). Hence it might be that languages that share similar social and physical contexts might develop in similar directions in terms of their structures. Another way of saying this is that the distance between similarly developed languages is relatively small. In such situations, the proficiency of L1 is important and it could effectively influence development of L2, as Cummins as shown. Such would be the case for similar European languages. However, in other cases two languages might not share similar developmental backgrounds, and thus their language structures may differ considerably and hence the language distance between them is large. Such a situation might be found in classrooms where an additional language was chosen as language of instruction in schooling process, but the children's L1 was the local native languages. There are two possibilities that emerge from this argument. It may be that there may be some dislocations between two languages, so that knowing L1 impedes becoming competent in L2. The second possibility is that, although there might not be any direct impediment from L1, it might not have been sufficiently developed linguistically to cope with a specified area of discourse and hence have little positive impact for L2 in that specified area.

Both Dawe (1983) and Clarkson (1992) showed how, for mathematics learning, the first of these possibilities does not occur. That is, language distance does not have such an influence as might be supposed. The second possibility was shown not to have a major influence on cognition, but it did have implications for how teachers used the language in the classroom. For example, Setati and Alder (2001) found that South African teachers could not shift in their talking from informal to formal mathematical language in African languages before going to English mathematical language, but instead went direct from informal African language to formal English mathematical language, because African language did not have well developed mathematics registers. In this situation, it was not only about proficiency of L1, but how well it was developed in particular ways in comparison to L2.

So far the researcher has discussed two theories, both of which emphasize the importance of language(s) in learning. Social-constructivist theory outlines a set of general social interaction practices that relate to instruction, and in turn shows how the role of language in this practice is crucial to learning. Since the major focus of this study is about using more than one language in the classroom, the theory of bilingualism was included to explain specifically when learning could be enhanced for a bilingual learner. It was shown that balanced bilinguals have a cognitive advantage over other learners. However, it takes between 5 to 7 years for a bilingual to reach the third floor (see Figure 2.5) after beginning to learn the language of the classroom (Baker, 2006; Cummins, 1981b; Cummins & Merill, 1986). Just how the two languages of a bilingual interact so that access to the third floor is attained is not fully understood. However, it appears that a key part of the process involves code-switching; that is, when a bilingual moves between his/her languages either mentally or verbally. It seems that this switching enables the bilingual to nuance ideas by examining them within the context of each language, and in apprehending the enlarged sense of meaning. The next section further explores these ideas.

2.4.3 Code-Switching as a Learning Resource

In this section the researcher discusses research findings that go some way to explain how languages are used, particularly through the language practice of code-switching, and the beneficial learning that follows from this for bi/multilinguals. The researcher focuses on two areas: how code-switching might help learning and how code-switching might play a role in developing language proficiency in both L2 and L1 for the learner.

2.4.3.1 Role of Learners' Main Language in Learning Mathematics

As described in section 2.2.5, code-switching involves the shift between two or more languages, in this case, between a learner's main language and language of instruction (English). In Papua New Guinea the language of instruction (English) is clearly valued at a policy level and also by most teachers. Therefore, it is to be expected that normally it is used more often in classroom situations than a learner's main language. Such a situation was also found in South Africa. The main reasons for this were related to power or politics, means to access professional jobs and language of internal community (Adler, 1996; Setati, 2002). Consequently, the learner's main language(s) are less used, thus implying they are less valuable. It is probable that a similar set of reasons also apply in Papua New Guinea.

Nevertheless, studies focused on code-switching in the recent past have shown that in mathematics classes students do use code-switching. These studies include those done in South Africa (Adler, 1996; Arthur, 1994; Setati, 1996) United States (Khisty, 1995; Moschkovich, 1996, 1999), Australia (Clarkson, 2006,) and Malaysia (Clarkson & Indus, 2007). These studies have either demonstrated the need and/or argued for the use of the learner's main language in learning mathematics as a necessary support while the learners continue to develop proficiency in the language of learning and teaching (LoLT), at the same time as learning mathematics. All these studies have been framed by a conception of mediated learning, and of communicative and cognitive functions of speech. Learners needed to talk to learn, and such talking to learn is a function of fluency and ease in the language of communication. In other words, talking is understood as a social thinking tool (Mercer, 1995). At this point it is useful to return to an early discussion of informal exploratory mathematics talk and conceptual mathematics discourse (see section 2.3.7).

In a classroom situation, how much a student speaks and in what language depends very much on the type of instruction used by the teacher in the classroom. The Setati et al (2002) study suggested that instruction that used a typical approach in teaching, the initiation-response-feedback (IRF) style, found that learners mainly used English in the public domain. The researchers found that the learner's main languages were not comfortably used by students, nor allowed to be used as a resource for learning by the teacher.

But, as noted earlier, constructivist theory strongly suggests that collaborative learning is a teaching approach that benefits the students cognitively. This theory sounds perfect, but in classrooms where the valued language of instruction is different from the learners' main language, collaborative talk is potentially far more difficult. Setati et all (2002) therefore suggested teachers tend to talk more and used an IRF style of instruction, allowing students to only respond in short phrases or words, concentrate on recalls of procedures. Even if the teachers tried to organize students into collaborative learning environments using the language of instruction, the students found it difficult to use the foreign language.

A change both at a policy level and teachers' perspectives of allowing or even encouraging the use of the learner's main language could lead to a change in instructional process. Such a change in language policy was implemented in South Africa (Adler, 1996; Setati, 2005; Setati & Adler, 2001). This is one of the reasons why instruction there has started to change to more group work, and such a change has promoted collaborative talk.

From a mathematics perspective, using collaborative talk in an informal exploratory learning environment becomes important. Setati et al (2002) found that talking in groups of peers seemed to be a comfortable environment for children. Interestingly, they preferred to talk in their main language, expressing their mathematical understanding of the topic. This not only helped learners develop skills of talking, but it also gave an opportunity for the teachers to gain insight into children's understanding. Setati and Adler (2001) further reported that the teachers were observed developing the children's informal exploratory talk into formal talk. They suggested this enabled children to see the connection between their own informal understandings with the new formal mathematical ways, thus making learning more meaningful. Such an approach enhanced effective learning as suggested by constructivist theory described earlier.

As indicated earlier, conceptual discourse involves giving reasons for using a particular procedure in solving mathematical problems. Such a process draws on personal understandings. This is most easily done by learners using a language that they speak fluently. Also important is a classroom environment where the teacher promotes students' self-expression. Only when the students can express their own reasons does the teacher have an opportunity of seeing their misunderstanding or understanding as the case may be. If in situations where English is the language of instruction but also a foreign language, and when only English is emphasized in the classroom, conceptual discourse will be that much more difficult for the children. Therefore, the language process of code-switching between fluently spoken vernaculars and English will help facilitate such mathematical talk. From research done in South Africa (Setati & Adler, 2001) and the United States (Moschkovich, 1996) in bilingual classrooms, it is clear that when the learners' main language was commonly used through the process of code-switching by the teacher for conceptual questions, the learnersmore easily and readily expressed reasons for using a particular procedure for a given problem. It was also clear from these studies that, when teachers did not use the learner's main language, this restricted children in their thinking, and they had more difficulty in giving reasons for why procedures were used (Adler, 1996; Setati, 2005; Setati & Adler, 2001). They also found that using the language-practice of code-switching as a learning resource also enabled the use of learners' main language for conceptual discourse.

What the researcher has so far discussed is how learning is enhanced through the use of learners' main language in an informal exploratory mathematical talk, and the hints in the literature that the language practice of code-switching is one way this can be enabled. Such use of language switching and usage appears to enhance learning of the subject, but the same process also promotes language development. In the following section the researcher briefly describes how language development is promoted through code-switching, where different languages were used simultaneously having beneficial effects on each other.

2.4.3.2 Code-Switching as a Resource for Developing Language Proficiency

A number of theories have been postulated as to how an individual acquires language. One of the most influential theories was formulated by Chomsky (1972, 1975,). Chomsky suggested that language acquisition takes place as the brain matures and is exposed to language. He also suggested that people are born with innate universal language structures embedded in their brains. However, such hard wiring of the brain is not the whole story. He also said children learn how to express the underlying universal language structure according to their particular culture. From this point of view, according to Skiba (1997), the addressees in conversations serve as facilitators of language development by means of exposing children to cultural elements required to express the universal language structure appropriate to the cultural and social requirements of the individual. Such a biological theory has not always been well received by others, particularly those who supported behaviorist views such as Skinner (1957 cited in Skiba, 1997). Behaviorists argued that language acquisition was just a verbal behavior and individuals were reinforced in their own speech patterns when these matched and hence were reinforced by the providers of affection during childhood. For example, grammatically correct constructions received supportive rewards as the individual tended to repeat them. A point to be noted here is that both theories (Biological & Behaviorist) recognized the importance of exposure to appropriate samples of language. This suggests that code-switching may also be a learnt behavior that also relies on the provision of appropriate language samples (Skiba, 1997). The listener, in this case, is able to translate what was said into the second language, thus probably facilitating deeper learning. In Cummins' (2000b) view, if such language sampling as used through code-switching occurs, both within additive and subtractive language environments, there will be positive progress in language development. In summary, although switching language during a conversation may be at times disruptive to the listener when the speaker switches, if it is one of the inherited linguistics skills of being a bi/multilingual, it probably provides an opportunity for language development. In some ways this is analogous to having to resolve a cognitive dissonance, which normally results in positive learning.

This section has concentrated on learning, which in a real way needs to be the main aim of teaching. With this background, we now turn to teaching, which is the central focus of the study and at the center of this thesis.

2.5 Teaching

As noted earlier, social-constructivist theory suggests that teaching can play a critical role for learning. A crucial process that is common to both teaching and learning is the communication process (Mercer, 1995). Among other things, the ways of talking and using language plays a major role in these processes. In this section, the researcher describes how languages, and in particular talking skills, are used to guide learning. The researcher first describes how talking guides learning generally and later the researcher discusses how the language practices of code-switching used by teachers can enhance learning. The researcher starts, however, with what Mercer (1995) called ‘the guided construction of knowledge’.

2.5.1 The Guided Construction of Knowledge

In section 2.4.1, the researcher has discussed the social-constructivist view with regard to how teachers, through the use of cultural symbol-systems such as language, seek to guide the learning of their students. Even though that discussion focused on learning, it acknowledged the role of the teaching process in the cognitive development of learners. This became obvious through Vygotsky’s (1978) description about the ‘More Knowledgeable Other’ (MKO) and his/her role within the ‘Zone of Proximal Development’ (ZPD). The role of MKO described by Vygotsky was that of a facilitator, guiding and encouraging the learners within the ZPD, using the notion of scaffolding. Even though social-constructivist theory described how important language was in the communication process that enhanced learning, there was no explicit connection made as to how an MKO should use language to communicate in the teaching process. Mercer’s (1995) view, using the ‘guided construction of knowledge’, fills this gap.

‘The guided construction of knowledge’ is an extension of social-constructivist theory. It makes explicit the implied view about the relationship between the teaching process and the learning process. At the centre of this is the communication process. According to Mercer (1995), the communication process is common and important in all societies; that is, one person helps another to develop their knowledge and understanding. In most cases, it is at the heart of what we call education, including both informal and formal education, and it combines both teaching and learning processes. There are many mediums of communication that have an impact on teaching and learning, but what concerns this study is the use of language and the techniques of talking, particularly those used by teachers to enhance learning. Mercer noted that the language and techniques of talking to communicate between informal educational settings such as a mother with her infant baby at home, compared to an expert craftsman with one or very small number of apprentices, will be very different. Both these will differ from verbal communication that occurs in more formal settings such as school classrooms. As Mercer argued, at one level, the difference between these and classroom education was obvious; the number of learners per teacher has an immediate effect on the kind and quality of communication involved. But another crucial difference between classroom education and more informal kinds of teaching and learning is that there was a curriculum to be taught. Teachers use and in many ways constrain the medium of language and techniques of talk, to share what they initially plan to teach.

Mercer (1995) noted that the obvious and visible parts of a curriculum are the facts, as well as the ideas involved in teaching and learning of a particular subject. This includes mathematics. But there is a more subtle quality to education knowledge. One of the most important goals of formal education is to help students acquire, recognize and develop specific ways of using language to learn the formal knowledge contained within the school curriculum (Adler, 1996; Gee, 1996, 1999; Halliday, 1978; Pimm, 1991). This formal way of using language is often referred to as 'discourse'. This includes mathematical discourse, which was discussed throughout section 2.3, and other discourses embedded within a school discourse that relate to each of the specific school subjects. Learning then does not just involve specific skills and facts. It also includes discourses for specific subjects. According to Mercer (1995), the crucial ingredient for this learning is mediated through the teaching process. In the following section, I will explore the general classroom discourses that are used by teachers to guide learning, within which mathematical discourse is embedded.

2.5.2 Teachers' Verbal Communication

The researcher uses two subsections to discuss this issue further. In the first sub-section, the researcher discusses the general skills of talking that are used in the general classroom. The researcher then discusses how languages in a multilingual context can be used within the language practice of code-switching by teachers (see section 2.5.3). These practices are related in that they can occur at the same time during a lesson. For convenience the researcher treats them separately.

There may be many ways teachers can talk to fulfill the aim of communicating with their students. However, in this section the researcher discusses the specific techniques of talking that are often purposefully used to guide learning. These techniques involve the teacher talking with the children and sharing the focus and aims of lesson and, indeed, the curriculum as a whole. The researcher discusses three ways of talking that involve the students and, thus, help guide their construction of knowledge: eliciting knowledge from learners, responding to what the learners say, and describing significant aspects of the shared experience (Mercer, 1995). The researcher describes each of them in detail in the following sections.

2.5.2.1 Eliciting Knowledge from the Learners

The first technique of talking Mercer (1995) identified is *eliciting*. This suggests teachers should elicit relevant knowledge from students so that they can see what the students already know and understand. In this way knowledge is seen to be 'owned' by students, as well as the teacher. This can be done in two ways, through direct elicitation or by cued elicitation. Direct elicitation involves teachers asking students for information that the teacher already knows. But for crucial aspects of the knowledge tree, the teachers do need to know if the students know what those answers are. If the teacher asks such a question of a class or group, and one member is unable to provide the required answer, a teacher will typically ask another student. This strategy may well be repeated if a right answer is still not forthcoming. If no-one seems to be able to answer, one might expect that a teacher to simply tell the class the answer. But providing the answer is one thing that it seems many teachers are often at great pains to avoid. Instead, they resort to what Mercer (1995) called 'cued eliciting'. This involves drawing out from the students the information they were seeking by providing strong visual and verbal hints as to what answer is required. In most cases cued elicitation can be achieved by rewording a question in a certain way, but often other features of the teacher's talk also play an important role.

This technique of *eliciting* certainly occurs in mathematics classrooms. Within this technique of talking, the shift between informal and formal mathematical language also takes place. In most cases, the technique of eliciting, particularly cued elicitation, can be used with informal mathematical language by the teacher to direct learners towards the use of formal mathematical language. Such techniques of talking subsumed by the shift between informal and formal language can also occur for both procedural and conceptual mathematical discourse.

However if teachers rely solely or excessively on eliciting, Mercer (1995) warns that students will not embark on deep learning. Hence, although eliciting has an important place in the repertoire of teaching techniques, two other strategies are also needed.

2.5.2.2 Responding to What Learners Say

The second key technique identified by Mercer (1995) was *responding to what learners had said*. The teacher's response not only offers students feedback on their attempts to answer questions but also incorporates what students say into the flow of the discourse, as the teacher combines students' contributions to build more generalized meanings. In other words, for teachers to sustain dialogues with their students, Mercer suggested it was best for the teacher to use what students said as the basis for what they said next. In this way, the learners' own remarks were incorporated into the teaching-learning process.

Mercer (1995) identified a number of techniques of talking in his study that had potential to guide learners' knowledge-construction. These included techniques such as confirming, rejecting, repeating, elaborating and reformulating. According to Mercer (1995) the most obvious way of doing this was through confirmation (as, for example, a teacher's 'Yes, that's right' to a pupil's answer). In addition, repetition of things learners said was another. This allowed the teacher to draw to the attention of a whole class an answer or a remark which was judged by the teacher to have educational significance. Another technique the teacher could use was to paraphrase or reformulate a pupil's remark, so as to offer the class a revised, tidied-up version of what was said which fitted in better with the point that the teacher wished to make. There were also elaborations, when a teacher picked up on a cryptic statement made by a pupil, and expanded and/or explained its significance to the rest of the class. Finally, Mercer suggested that wrong answers or unsuitable contributions should be explicitly rejected by a teacher. This was in contrast to Mercer's (1995) observation of teachers commonly ignoring wrong answers.

These techniques of talking can be important in mathematics classrooms, because they can promote the formal mathematical language and ways of talking both in procedural and conceptual discourse. When teachers use the technique of responding to children's responses by way of confirming, rejecting, repeating, elaborating and reformulating, students can be guided to learn formal mathematical language, using it in both procedural and conceptual discourse. In other words, this way of talking consciously, using multiple techniques, would appear to be one way of promoting the formal languages of mathematical discourses.

The talking techniques of eliciting, if not used with care, can lead to the situation where there is little sharing of the learning situation between teacher and students. Mercer's (1995) third technique is structured to counteract this tendency with a direct emphasis on sharing.

2.5.2.3 Shared Experience made Explicit

The third technique of talking Mercer (1995) identified was to describe the classroom experience so that teachers shared with students in such a way that the *educational significance* of those joint experiences was revealed and emphasized. Mercer (1995) suggested three techniques that served this purpose; using 'we' statements, literal recaps, and reconstructive recaps.

'We' statements, as when a teacher says to a class 'last week we learned how to measure angles', can often be used by teachers to ensure past experiences are made relevant to the present activity. In this way the teacher helps learners to see that they, the students, both as a group and with the teacher, have significant past experiences in common, and so can gain shared knowledge and collective understanding in the present and future. These can be drawn upon to advance their joint understanding. In using ‘we’ statements, the teacher is normally retelling, or asking students to retell, literally what has happened: in Mercer’s terms, a literal recap. Again this reinforces the notion that the group is learning together. An interesting variant of this is when the teacher or students cannot give a literal recap, but have to reconstruct a shared experience. This also includes occasions when a teacher emphasizes specific aspects of the shared experience at the expense of all other aspects. Mercer (1995) cautions that while this can be useful for helping learners see what the teacher was trying to say, it may create problems if the reconstruction was too imaginative to fit the events as remembered by the learners themselves.

Such techniques of talk can also be found in mathematics classrooms. Since mathematics is often seen as a sequential subject, which in most cases builds itself from initial ideas, the technique of recapping is important. Earlier ideas in mathematics are routinely needed to reinforce the ideas that are newly introduced.

So far the researcher has discussed some techniques of talking identified by Mercer (1995) as classroom discourse that teachers use in general to guide learning. The researcher has also suggested that although Mercer was dealing with the general school classroom, these practices equally apply to mathematics language and discourse. However, in a bi/multilingual classroom context, many other language options are available. In the following section, the researcher discusses how the uses of such languages through the language practice of code-switching can also potentially help to guide learning.

2.5.3 Code-Switching as a Teaching Resource

Earlier sections of this chapter have noted the extent of code-switching used by students in learning. It was also suggested that the closest context to that of Papua New Guinea for which there is a useful research body of work is that of South Africa. Hence in dealing with the notion of code-switching and teacher-talk, it is this work on which the researcher concentrates.

2.5.3.1 A Comparison between South African and Papua New Guinean Language Policies

In this section the researcher describes the similarities and differences of background language-policies, and the structure of schooling sectors responding to the new language-policy and language-practices in South Africa, with those in Papua New Guinea. This description is intended to show that the data collected and findings reported from South Africa aimed to answer a research question that was different from that of the study presented in this thesis. Nevertheless because of parallels between the two countries, the South African results remain important for this study.

There are three situations related to language in education in South Africa that are similar to the situation in Papua New Guinea. First, in South Africa most teachers and children already speak and use more than two languages before learning English at school. For example, they are able to speak a home language(s) and a national language such as Afrikaans, before using English at school. This is similar to Papua New Guinean classrooms, where children speak their local language and Pidgin or Motu, the national languages, before they come to school and meet the language of instruction (LoLT), English (Clarkson, 1991). Second, due to this language environment, the governments of both countries introduced a similar language policy that affected language-use in mathematics classrooms. These policies allow the students' most common language to be used within classroom instruction. In South Africa the new language policy came into effect in 1997 (Setati, 2002) and in Papua New Guinea in 1992 (*Mathematics - Lower Primary Syllabus*, 2004). In South Africa, as indicated in section 2.3.8, teachers are allowed to use 9 African languages, as well as Afrikaans and English for classroom instructions. Similarly, in Papua New Guinea, teachers are allowed to use any of the 817 local languages, Pidgin, Motu and English for instruction purposes (*Mathematics - Lower Primary Syllabus* 2004). Thirdly, due to these policies, the natural language practice of code-switching has been promoted in both countries. Language practices reported in other studies such as those by Cummins (1981b) and Cummins and Merill (1986) assumed code-switching as a mental process. But the practices in South Africa involved the behavioral practice of language-switching while teachers taught mathematics. Such a language practice is similar to Papua New Guinea classrooms, although mainly emphasized in the lower primary grades.

However there are also some important differences to note in the contexts of these two countries. First, within the language-education policies, there are slight differences which might affect the teacher's use of different languages in their instruction. In South Africa, there is no specification as to how frequently any particular language should be used at a grade level. According to Setati (2002), the only specification in the language policy in South Africa is for teachers to have a bilingual environment. At least two languages can be used at any one point of time in the classroom situation, where one of these languages should be English and the other one must be any one of the 9 African languages. Butit does not say how much of each language can be used per grade in all schooling sector. Teachers are given this responsibility. This means that, at the primary school level, where students are fluent in their local language but have had limited exposure to English, teachers were expected to decide which language to use. In fact it will be shown in the findings below that teachers emphasized the use of English, even though children did not speak it fluently. This differs from the language policy in education handed down by the government of Papua New Guinea. The policy specified how much each language should be used depending on the grade level (see specifications described in chapter 3). In this case, at the lower primary schooling sector and particularly for the bridging class (grade 3), teachers were expected to use 60% of local languages (learners main language) and 40% English. The difference in policy environments could be one of the factors that affected the use of different languages, particular by teachers in mathematics classroom

A second difference to take account of when comparing the frequency of use of the multiple languages available in South African and Papua New Guinea classrooms is the geographical location of the school. It is assumed that more local languages might be used in rural schools than urban schools. The research findings from South Africa discussed below came from urban secondary and primary schools. However, this study aimed to distinguish the role of local language used by teachers who taught in rural primary schools.

However, even given these two important differences in government policies and the contexts of the research studies, an examination of the South African studies is important.

2.5.3.2 Code-Switching in Mathematics Teaching

Together with the verbal techniques discussed in section 2.5.2, teachers in multilingual classrooms also have the option of using the available languages to guide learning. This section focuses on how teachers can potentially use the different available languages through the language practice of code-switching. A particular focus will be placed on the role of the learner's first language. In the earlier section 2.4.3, I have shown that the language-practice of code-switching is potentially an effective resource for both learning and teaching and described how it was used for learning. I now turn to teaching mathematics.

There are a limited number of studies related to teachers' use of languages in bi/multilingual classroom for teaching mathematics in primary schools. Few of these mirror the situation of Papua New Guinea classrooms. Those that do come from South Africa, in particular Adler (1996), Arthur (1994) and Setati (1996). In this section I will describe these research findings into how the learner's main language and the language of instruction (English) were used, and the use made of the language-practice of code-switching by teachers of mathematics.

The first result to note was that both languages were used in mathematical discourse, but English was used more for procedural discourse, and the learners' main language was used for conceptual discourse. Setati et al (2002) summarized the form of code-switching that took place in most classrooms by teachers in South Africa. She noted that in the public domain, teachers used English predominantly for initial teaching. However, they switched to the learners' main language(s) for reformulation in public whole-class teachingand, more generally, for interaction with individual learners or small groups. She then discussed the language used by teachers in each of procedural and conceptual discourse.

According to Setati (2005), in a mathematical classroom, while procedural mathematical discourse was in progress, the common instructional mode was teacher initiation-student response-teacher evaluation (IRE). Such an approach obviously drilled students to remember procedure. While the teacher was engaged in such discourse, the students were expected to respond in a repetitive manner since the teacher wanted to promote, for example, the procedures involved in calculating a problem. The teacher's aim was invariably narrow, and clearly repetition by the students was called for. English was used for such very formal kinds of talk, because part of learning mathematics was to reinforce the use of formal mathematical talk in English (Adler, 1996; Setati, 2005). From such observations it was concluded that English was the language of procedural discourse. Such talk was what Arthur (1994), writing about teaching in neighboring Botswana, termed as 'final draft', seemingly devoid of meaning.

However, occasionally within procedural mathematical discourse, teachers would switch from English to the learners' main language when talking to the whole class. According to Setati (2005), such a switch occurred to reformulate language aspects that had been already expressed in English, but that the teacher thought were crucial ideas, which the children needed more help in understanding.

On the other hand, when the teacher was interacting with individual students, the learners' main language was used while the teacher was promoting procedural mathematical discourse. This mainly involved the teacher supervising and moving around in the classroom, thus having the opportunity to interact with individual students. While talking with children, according to Setati (2005), teachers mostly used informal ways of discussing mathematics, mainly to help students understand the formal procedural mathematical discourse. However, even in these one-on-one situations, when English was in use, teachers mainly focused on drilling students to remember their perceived correct procedures of solving a problem. Hence it seems that the learners' main language was used for understanding, unlike English that was used to drill procedures.

Both procedural and conceptual discourses are crucial in acquiring fluency in mathematical discourse. However, in the South African classrooms, conceptual discourse was not seen as valued knowledge in comparison to procedural knowledge. This was evident, according to Setati (2005), in the written exercises that the teacher gave the learners, and also in the class test at the end of the lesson. In most cases, the assessment tasks communicated to the learners what was valuable knowledge. The absence of questions demanding fluency in conceptual discourse in the class test suggested that procedural discourse was the discourse of assessment. Although conceptual discourse was used in the teaching, it was not the discourse of the assessment, and thus was absent from the test. As has been already seen, English was the language preferred by the teacher for procedural discourse. The researcher has also noted that, since most assessment tasks assessed procedural knowledge, students assumed procedural knowledge was of higher importance. These two ideas gave English a higher status than that of the other languages.

Even given the different status of languages, it was evident that both the main language of the learner and English were used in nonmathematical discourse, but they were used to serve different purposes (Adler, 1996; Setati, 2005; Setati & Adler, 2001). The teacher used the learners' main language for solidarity purposes. This involved the use of the collective pronounces such "we" and "us" in the teacher's talk, suggesting that the teacher was concerned with the learners. Such language use expressed the voice of solidarity, suggesting that they were here together. Thus the teacher signaled that she/he was part of them and would help them learn. On the other hand, English was used to give firmer instructions. Such use of English expressed the voice of authority. English was used to gain attention and demanded a response to the request of the teachers. Such language-use suggested that English was the language of authority and power.

In this subsection, the researcher has discussed research that has focused on studying the use of languages for different purposes in mathematics classrooms, with particularly emphasis on how the learners' main language was used within mathematical discourse, and also nonmathematical discourse. It is clear that the learners' main language was used during procedural discourse to reformulate aspects which needed emphasizing by the teacher for students' understanding, and to ask conceptual questions, or as a prompt in word-problem activities, to get children to give reasons for using various procedures to solve problems. Such language-use was the result of using the language-practice of code-switching. But there were many circumstances that the research identified that discouraged the use of code-switching, and indeed emphasized the use of English.

2.5.4 Tensions with Using Code-Switching

In an earlier section the researcher examined how languages were used in a bi/multilingual classroom in primary schools in South Africa. The researcher discussed how each of the languages was used for different discourses in mathematics classrooms. The switching of languages maybe be a natural practice for bi/multilingual speakers, but the research findings indicated that such choices and use of language by teachers were deliberate decisions. In practice teachers deliberately chose to use English more than the other African languages, even though the same emphasis was given to all language at the policy level. Clearly there was a tension between what languages would be used when teachers had to resolve issues in their day-to-day teaching. According to Setati (2005), teachers struggled between promoting English on one hand and teaching for understanding through the use of learners' main language. The teachers emphasized the importance of using English, because it was the language of power; it was needed to secure jobs and gain access to the international community, it was the language of text books and of key public service examinations (Adler, 1996; Setati, 2005; Setati & Adler, 2001; Setati et al., 2002). On the other hand, teachers also indicated that it was important for their students to understand the important meaning of each mathematical concept they taught. Since English was a foreign language and students could easily misunderstand meanings encoded in English, they switched to using the learners' main language to ensure deep understanding of the concepts they were teaching. Therefore, they had to use the language practice of code-switching. This enabled them to deliberately choose languages available for two very important reasons.

2.6 Conclusion

This chapter has reviewed the important place of language communication in both learning and teaching. It has shown that the language of mathematics teaching is multifaceted even in a multilingual environment. In a multilingual classroom, the language context becomes far more complex. Research from South Africa shows those teachers in multilingual mathematics classrooms do feel under pressure, but resolve the tension by consistently using the languages available in quite consistent patterns. These results are seen as a template for examining how some primary school teachers in Papua New Guinea choose to use the available languages in their classrooms when teaching mathematics. Before moving to discuss the methodology for this study, the context of Papua New Guinea will be dealt with in the next chapter.

CHAPTER 3 LANGUAGE PRACTICES IN PAPUA NEW GUINEA EDUCATION

3.1 Introduction

Culture and linguistic diversity occurs for a variety of reasons. In developed countries these often include influxes of immigrants, refugees and international students, while large numbers of developing nations have long contained several language groups within their boarder. The latter situation is found in Papua New Guinea, in whose language environment people regularly speak more than one language. Such a multilingual situation poses challenges in educating the children. The challenge related to this study is how such a language situation could be used for educational purposes, but at the same time take into account the need to promote a national identity and deal with globalisation. Some countries are seeking to address these challenges through a bilingual education policy. Such a strategy aims to have a basic education for everyone using the home language(s) of the children. This goal cannot be accomplished unless minority or vernacular languages are included in the formal education system. Papua New Guinea is one of the developing countries with such a bilingual education policy. A reform of the country's English-only policy education system was launched in 1992 (*Language Policy in All Schools, Ministerial Policy Statement, no. 38/99*, 1999). This new government policy requires the national formal education system to include vernacular language education in the initial years of a child's education, then to implement a gradual transition to the use of English as one of the languages of instructions, and finally to use English as the main language of teaching. This chapter reviews the progress made related to language and its use in Papua New Guinea's education system. Hence it will give the immediate context within which the study for this thesis was conducted. The researcher begins by considering the number of languages found in Papua New Guinea, then describes the history of language use in schooling system from the time of colonial rule up to the present.

3.2 The Number of Languages in Papua New Guinea

Papua New Guinea is unique in a number of ways compared with other developing countries. A key one is the huge number of languages spoken by the indigenous citizens. Papua New Guinea is the world's most linguistically diverse nation with 817 living distinct languages spoken by a population of more than 6.3 million people ("Languages of Papua New Guinea," 2008; Wroge, 2002) . According to Klaus (2003), Papua New Guinea has about one seventh of the 6000-plus languages of the world. The population of each language group is small compared with many other indigenous languages around the world. The largest language group, *Enga* has only 165,000 speakers found in Enga Province (Klause, 2003). None is numerically or politically dominant across all of Papua New Guinea. Multilingualism is common, with many people speaking their first language, plus one of two lingua franca; Melanesian *Pidgin* or *Hiri Motu*, but not in a second-language context. Most people have little exposure to English unless they live close to towns or cities, with only 50, 000 people speaking English as their first language. The following section will consider the history of how this language situation of Papua New Guinea was dealt with for schooling purposes.

3.3 History of Language Policy in Education in Papua New Guinea

The colonial powers in Papua New Guinea played a major part in introducing the two nationally spoken lingua franca, Melanesian *Pidgin* and *Hiri Motu*, in addition to the existing 800+ languages. Historically, in the 1880s the Dutch, German and British colonial powers claimed different parts of the Island of New Guinea and nearby islands (Litteral, 1993). The Dutch claimed the western half, which is now part of Indonesia (the provinces of West Papua and Iran Jaya), the Germans the northeast, and the Australian/British the southern section near Australia. The Germans utilized an English-based pidgin, '*Tok Pidgin'*, as the lingua franca in their territory. In the Australian/British territory a pidgin with a vernacular lexical base, police *Motu* (now called *Hiri Motu*), was spread by the constabulary and became the lingua franca. British New Guinea was renamed Papua and became a colony of Australia in 1906 (Litteral, 1993). The Australian armed forces took control of German New Guinea in 1914, and in 1919 Australia assumed responsibility for it as a mandated territory. However, *Tok Pisin* continued as the lingua franca of the north east. After World War II these two territories were administered jointly by Australia as the territory of Papua and New Guinea, until they became the independent state of Papua New Guinea in 1975.

Because of the linguistic complexity of Papua New Guinea, it is perhaps not surprising that there has been a long and often acrimonious debate concerning language in education. The controversy goes back at least to the early years of the twentieth century. From 1870 until 1950, the majority of schools in Papua New Guinea were established by Christian missions and the vernacular languages were used as the language of instruction . The primary purpose of their education was for religion, especially reading the Bible. During this era most children who served in the missions became literate. Communities were primarily passive recipients of education and had little input into education decisions as these lay with expatriate mission organizations. For these organizations accountability was primarily to overseas councils of the mission and not with the communities they served or with the government. Hence, this was an era of decentralization with regards to language policy, with non-government organizations (NGOs) primary providers of education. The colonial government provided some assistance, through subsidies to the missions, and began steps toward providing higher education.

As the colonial government began to assume more active control of education in the 1950s, their policy was determined by the perceived need to westernize the nation through education (Gunther, 1969). They made English the language of education at all levels and enforced this policy by withdrawing subsidies from missions and churches that did not use English in their education programs. At Papua New Guinea's independence in 1975, the policy was reviewed but maintained under the 1976 Education Plan. Even so there was still ongoing debate concerning language policy for schools, including disquiet about the English-only official policy. There was a concern that an English-only school system was alienating children from their own language and culture (Clarkson, 1983; Literal, 1993). Several of the new 20 decentralized provincial governments heard this concern expressed by parents, and took steps to introduce a vernacular education outside the formal schooling system. One of these provinces was the North Solomon's Province. There the Bougainville Islanders proposed giving their children two years of preschool education in their own language before the first grade of primary schooling, and then moving to English as the language of instruction in primary school. The *Viles Tok Ples Skul* (VTPS) ("Village language school") schemes thus emerge as a non-formal community-based vernacular language preschool education option. Later, it became known as *Tok Ples Pri Skul* (TPPS) (Vernacular preschool). By the early 1980s this movement was gradually spreading, first to Chimbu province, and then to a number of other provinces.

A review of the VTPS programme found not only that children who attended a village vernacular preschool before entering the first grade experienced distinct educational advantages, but also that their communities enjoyed social and cultural benefits (Delpit & Kemelfield, 1995). Primary schools teachers noticed that the transition to the English-only classroom was much easier for children who attended the vernacular-language preschool compared with those with no previous educational experience. A major assessment was completed across the whole education system in Papua New Guinea in the early 1980s by a group chaired by Sir Paulias Matane and produced the influential report called the 'Matane Report' (Matane, 1986) . This report, and those from Bougainville, was the basis for the recommendations of major education reform. One critical recommendation was to change the English-only policy. This report recommended that local vernaculars could be used within the formal education system. The following section describes this new language policy.

3.4 The New Language Policy in Education

In July 1991, following the proliferation of vernacular preschools (TPPS) in PNG, officials from national and provincial departments of education unanimously agreed that the formal education system needed restructuring. This eventually led to the 1995 Education (Amendment) Act (*Language Policy in All Schools, Ministerial Policy Statement, no. 38/99*, 1999). The education reform, primarily designed to improve educational access, equity and quality, also defined the use of vernacular (local language) in each schooling sector.

The new language policy for schools in Papua New Guinea recommended a specific language transition-phase take place before English became the main language of instruction. This phased transition was planned to take place in the first nine years of schooling, across Elementary and Primary Schooling Sectors. Table 3.1 shows the language use specification for Elementary and Primary Schooling Sectors under the new language policy.

Table 3.1 Language Specification (Mathematics - Lower Primary Syllabus, 2004)

Elementary			**Lower Primary**			**Upper Primary**		
P	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Vernacular			Bridging & Bilingual Education			English as a Second Language & Vernacular Maintenance		

According to the new language policy, formal schooling would begin with using only vernacular language instruction in the first three grades of a child's elementary education (Elementary-Prep, Elementary-1, and Elmentary-2). Oral English is introduced as part of the Elementary-2 curriculum. By upper primary year 8, English is to become the main language of instruction. But importantly the policy noted that vernacular could be used if necessary, not only to maintain local vernacular languages, but also for understanding subject content in any year level including in years 6, 7 and 8. As indicated in *Upper Primary Mathematics Syllabus* (2003, p.4);

> While it is recognised that English is the main language of instruction it must also be recognised that students are still more familiar with their vernacular or lingua franca and their teacher should encourage their use where it will lead to better understanding.

Between these two end points of the schooling sectors is the lower primary. According to the policy, the lower primary grades (3-5) were to be taught in vernacular and English. This implied that these grades would have a bi/multilingual environment. The way these languages were to be used in classroom situations was also dealt with in the language policy. A bridging process was envisaged. This is clearly spelt out by the policy document (*Lower Primary Syllabus* , 2004, p.3) in a number of places:

> At the Lower Primary level (Grades 3-5) the learning and teaching will be conducted in a bilingual situation, in which there is planned, gradual bridging from vernacular (or the lingua franca) to English. Oral and written vernacular development will continue throughout Lower Primary. Oral and written English development will gradually be introduced and established as the major language of instruction by the end of Grade 5…
>
> At the Lower Primary level, while English is being learned, the language mostly used for teaching and learning should be the same language that the children used in Elementary school.

> Where a number of active languages exist in one community, the main language of interaction between the language groups and of commerce in the community should be the language selected, that is the local lingua franca.

Hence, this policy recommended bilingual education in the lower primary school grades. It is worthwhile at this point to highlight two key issues included in the policy. Firstly, it is recommended that at least two types of languages are to be used at the lower primary. The first would be one of the 817 vernaculars, or, when more than one vernacular language is spoken within the same school, the common lingua franca (*Pidgin* or *Motu*) should be used. The other language should be English. Second, there should be a gradual shift from more of vernacular in the third grade to more of English in the fifth grade. Within this bilingual classroom environment, the language practice recommended is a 'bridging process'. The researcher explores more fully the notion of language bridging in the next section.

3.5 Bridging Process at the Lower Primary Sector

In summary, the policy notes that students should complete elementary education in their vernacular. Bridging to English is the gradual change from using vernacular to using English for instruction during grades 3 to 5. The linguistic intention behind this proposal is to use a fluently spoken language to act as a bridge or resource to help learn the new valuable language of English, and, in particular for this study, mathematical English. It is agreed in the policy that in such a bridging process, by maintaining the vernacular language, students retain their identity, culture, self-confidence and self-esteem. Using vernacular language for continued learning and development while English is being learned is an effective way for Papua New Guinean students to develop their full potential.

Table 3.2, shows the suggested gradual progression from vernacular to English. It is anticipated that, as students become more confident in their English skills, the time allocation in vernacular instruction will be reduced. The policy was to apply across the whole curriculum, not just for language-based subjects. Hence it was applicable to the teaching of mathematics. Therefore, in the Mathematics - Lower Primary Syllabus (*Mathematics - Lower Primary Syllabus*, 2004), at the third grade students and teachers are expected to use

60% vernacular and 40% English, fourth grade 40% vernacular, 60% English, and fifth grade 30% vernacular, 70% English. Such a break-down clearly implies that English is considered important, but help for its learning in the form of the commonly fluently spoken local vernacular is needed to create a bridge to meet the gap in learning while English is still new to the learners.

Table 3.2 Suggested Percentage Use of Vernacular and English in Lower Primary (Mathematics - Lower Primary Syllabus, 2004)

Elementary Grades				**Grade 3**		**Grade 4**		**Grade 5**	
Preparatory	**E1**	**E2**							
Vernacular	Vernacular	Vernacular	English	Vernacular	English	Vernacular	English	Vernacular	English
100%	100%	80%	20%	60%	40%	50%	50%	30%	70%

3.6 Interpreting the New Language Policy in Education

There are a number of interpretations that could be made from the overall policy for language-use in the initial schooling sectors discussed above. It is obvious that the new policy emphasised the importance of all languages; each of the 817 vernacular languages of Papua New Guinea, the two lingua franca, and English. In interpreting the policy related to using the local language, there are three obvious targets of the policy in emphasising the use of the local vernacular in the schooling sector in Papua New Guinea.

First, through its use in the schooling sector, it is hoped local vernaculars will be maintained, so that the young of succeeding generations will continue to speak their language. Even though there is a progressively increasing emphasis on English, at the policy level teachers and students are still encouraged to use the local vernacular. According to the policy, this was to enhance understanding in upper grades and beyond. But, significantly, the local vernacular will continued to be maintained at all levels throughout the primary sector. As Skutnabb –

Kangas (2003) commented, using fluently spoken local language certainly encourages cognitive development of bi/multilingual learners, but, even more importantly, such a language practice promoted at a policy level is a model for the rest of the world because it helps to protect endangered languages from being overrun by economically powerful languages such as English, whose dominance is one aspect of globalisation (Clarkson, 2011).

Secondly, the local vernacular is intended to be used as an aid, or a resource or a bridge to help teach and learn English, in this case mathematical English. This policy implies that English is the important language for future generations, through which they will find jobs, conduct trade and interact with the international community. However, unlike in the old education practices, the recent education policy does not promote English exclusively, at the expense of local vernacular. It promotes both.

In addition to thesetwo obvious interpretations of the new policy, there is also a third target: the linguistic development of the local vernacular. As the researcher has indicated in chapter 2, Cummins' (1981) hypothesis suggested that in the event of the local vernacular becoming an aid for learning another language, English in this case, this process does have a reverse effect, in which the learner's fluently first spoken language receives some mutual benefit from the influence of learning, in this case, English. The effect arises from the challenge of using a local vernacular to express concepts which have never been part of the culture in which the local vernacular has evolved. For instance, most local vernaculars in Papua New Guinea would face difficulty in expressing many new mathematical concepts found in the school curriculum because they will lack terms and linguistic devices that could express them. But in the process of becoming a bridge or resource to assist in expressing or enabling understanding of the new concepts in English, the spin-off benefit could be that the local language can undergo linguistic development and restructuring. A good example of such development would be code-borrowing, occurring successfully within grammatical structure of the local language (Setati & Adler, 2001). A mathematical term, such as kilogram, used within a sentence structure of Wahgi, could be a good example (see Chapter 5 for this and other examples).

One other implication of the bridging process as embedded in the new PNG language policy is the language practice that will obviously take place; that of code-switching. However, this language practice was not clearly discussed in the new policy, even when shifting to and from the local languages was emphasised for learning English and understanding new concepts. Since such a language-practice is at the centre of this study, the following section discusses the interpretation related to the language-practice of code-switching within the context of bridging process.

3.7 Code-Switching

In section 2.2.5 the researcher has defined the term ‘code-switching’ as shifting between two languages by a bi/multilingual in a single communication process. One implication of the bridging process recommended in the 1995 Papua New Guinea language policy for schools, without doubt involves code-switching. The curriculum specified how much each language is to be used, but did not specify how such language shifts could occur for effective teaching. Such a practice, to use one language to teach another language, requires a certain pattern of switching between the two languages to enable an effective teaching within the bridging process, but this was not specified in the policy. As Adalberto (1988) noted, not all forms of code-switching are regarded as acceptable in the bilingual classroom. Language alternation encouraged by the teacher in a bilingual classroom must be meaningful and purposeful, and not simply reflect a language choice available to the teacher. A teacher who is bilingual should have some specific knowledge of bilingual behaviour that can be instrumental in constructing an effective code-switching practice in a bilingual classroom. This would include knowledge that will enable a bi/multilingual teacher to decide what language to use, and when to switch between the local vernacular and English for an effective teaching of mathematical English within the bridging process.

No study has researched what are appropriate patterns of switching languages within the bridging process in Papua New Guinea. The study for this thesis is likely to start to fill that gap by identifying patterns of code-switching that could enhance effective teaching within the bridging process. In particular, one of the case studies, which the researcher relates in Chapter 6 will emphasise this central point.

So far, the researcher described a brief history of language in education in PNG, and described the overall new language policy which is being implemented under the recent education reform in Papua New Guinea. The following section explores briefly the history of mathematics curriculum in PNG and its emphasis on language use.

3.8 Mathematics Education in Papua New Guinea

The general history of schools and the new language policy discussed above both both have an impact on all schooling subjects, including mathematics. In order to trace language-use in teaching mathematics in PNG, it is first relevant to trace the history of mathematics curriculum-development.

3.8.1 History of Mathematics Curriculum Development

The movement to effect the modernisation of mathematics curricula, which swept the world in the sixties, had affected the curriculum in Papua New Guinea by1964. According to Roberts (1978), in 1963 a commission for higher education was set by Australian department of external territories, chaired by Sir George Currie, to look into the needs of education in Papua New Guinea. Following the Currie report, Professor Z.P. Dienes, an educational psychologist at the University of Adelaide, was invited to outline a theory of mathematics-learning and to advise on the design of a suitable modern mathematics course for Papua New Guinea.

Traditionally, mathematics courses in schools had concentrated mainly on arithmetic with children rote-learning responses to stimuli, especially the algorithms of numerical operations. However, the modern or new mathematics course was far broader, covering and linking numerical, spatial, algebraic, and other concepts (Roberts, 1978). The new course attempted to lead children, by use of a variety of structured aids and activities, to an insight into the logic and underlying structure of mathematics. The new mathematics methodology required a change from teacher-centred instruction to a child-centred one. The orientation of classroom activities was towards a heuristic method, leading the child to discover the concepts involved.

The Currie report had recommended this type of teaching approach. During 1965 and 1966, Professor Dienes was engaged to work in Papua New Guinea, carrying out trials of materials, workshops and seminars for teachers. At the start of 1967, a new syllabus for primary T schools was introduced and it contained two syllabuses for mathematics, one labeled arithmetic and the other labeled mathematics (Roberts, 1978). These were for preparatory and standard 1 class. While work continued with the aim of developing a course and text-book material for grades 2-6, text-books developed by Dienes to be used in South Australia,called *Primary Mathematics Series (P.M.S),* were used in the PNG schools. In 1971, a new course was finally finished for PNG and this was called *Mathematics for Primary Schools,* commonly referred to as MaPS. The MaPS course became known as *Mathematics for Community Schools,* commonly called MaCS, when primary schools were retitled community schools in the mid 1970s. The MaCS course was trialed to be used in all grades nationwide in 1978. The course contained five strands; logic, relations, number, measurement and geometry. This course was used with some modifications until the recent new change in education reform.

The MaCS curriculum materials were designed by foreigners and used as its basic model a curriculum developed in New South Wales, Australia. The curriculum was written in English and it was assumed the language of instruction would be English. This was supported at the government level, both before and after the independence of Papua New Guinea. The curriculum may have been well structured and targeted child-centred lessons, but from an early date the language problem was an issue identified as affecting the performance of children in Papua New Guinea. As Roberts (1978, p. 209) acknowledges,

> Language difficulties remain a considerable obstacle to the full and effective implementation of MaCS. There is evidence that the problems attendant to the use of English as medium of education are growing.

Before examining more deeply the issue of language impacts on mathematics in PNG, I will briefly sketch in the more general changes made to the mathematics curriculum in the mid 1990s.

Due to the new policy change and the recent education reform, there has been change in curriculum for the elementary and the primary school sectors. This has been the case for all schooling subjects, including mathematics. The teachers in the elementary schools could now use a syllabus and teachers' guides called '*Cultural Mathematics*'. For the primary schools, the syllabus and teachers guide is called 'Mathematics'. There is a separate document for the lower primary (grades 3-5) and upper primary (grade 6-8). The contents are summarised in Table 3.3.

Table 3.3. Summary of Mathematics Curriculum (Lower Primary Mathematics Syllabus, 2004, p.1)

	Elementary	**Lower Primary**	**Upper Primary**
Subject	***Cultural Mathematics***	***Mathematics***	***Mathematics***
Strands	Number Measurement Space Chance Patterns	Number and Application Measurement Space and Shape Chance and Data Patterns	Number and Application Measurement Space and Shape Chance and Data Patterns and Algebra

There are five similar strands (content) recommended for each of the three sectors. The concepts for the elementary sector are mainly to be drawn from the immediate culture of the students and this is emphasised by using the title 'Cultural Mathematics'. In the primary sectors examples are to be drawn from cultural mathematics to explain western concepts in each strand. Embedded within each of these content guidelines, there are suggestions for language use and practices. Generally, the specifics of what and how much each language is to be used in bilingual mathematics classrooms in Papua New Guinea is almost the same as the general language policy described in section 3.4.2. However, the following section first explores what is described in the mathematics curriculum as specifically related to language, before reviewing briefly the research on which this advice was based.

3.8.2 Language use in PNG Mathematics Classroom

As indicated earlier, in the preparatory grade and grade 1 of the elementary sector the curriculum recommends that the language of instruction should be the one that the students speak fluently. Hence the languages of instruction could be a local vernacular, a lingua franca (Pidgin or Motu) or both, and English. In grade 2 of elementary school, 90% of the local vernacular(s) is expected to be used, but 10% of oral mathematical English is also to be introduced. At the lower primary (grades 3, 4 and 5), the teachers and students in a lesson could use 60%, 50% and 30% of a local vernacular, or a lingua franca (*Pidgin* or *Motu*), or a mix. On the other hand, within the same lesson, teachers and students could also use 40%, 50% and 70% of English, in grades 3, 4 and 5 respectively (Lower Primary Mathematics Syllabus, 2004). The teachers and students in the upper primary (grades 6, 7 and 8), are expected to use 90% of English and 10% of local vernacular.

The reason for such a language use in upper grades is described in the Upper Primary Mathematics Syllabus (*Mathematics Upper Primary Syllabus*, 2003, p. 4);

> Since mathematics is itself a language and one different from any other language, it is believed that the use of their first language will help the students to understand better when dealing with mathematical activities.

This statement acknowledges that the knowledge of mathematics involves specific language use. In Chapter 2, the researcher has emphasised that mathematics is a set of meanings and is not a language, and that any language could be used to express this meaning. However, there are challenges to the extent to this which can occur. Vagi and Green (2004) experienced this challenge when training elementary teacher trainers and teachers in Papua New Guinea, under the recent education reform. They found that some of the teachers were unable to find mathematical terms in their local languages. This problem was obvious through Lean's (1994) studies that aimed to identify number names from more than 1000 languages found within Oceania, of which 600 languages were from Papua New Guinea. This study was unable to list number names beyond 5, 10 or 20 in most Papua New Guinean languages. This was confirmed by Muke (2001) in his studies within *Wahgi* culture; that there was no number name or practice of number combination for numbers 100 and beyond in *Wahgi* language. With such knowledge and its associated vocabulary missing, it becomes challenging to express a new concept that has never been part of the culture and its language. For instance, a teacher in Wahgi trying to express the concept of 100 in the local vernacular in a grade 3 bridging class is challenged, because culturally there is no need to quantify to that extent: there is no number name or number combination established to express such a meaning. This is because knowledge and language develop together, and it becomes challenging when mathematics developed in other cultures is to be expressed in a language with a different cultural background. However, languages are bound to change, and through language practice such as code-switching, some new meanings can be successfully expressed. For instance, in Wahgi the concept 100 is expressed as; *hundred endi*, borrowing the term 'hundred' from mathematical English and using it with the existing number name *endi* in Wahgi language, and hence expressing the concept one hundred (see Muke, 2001 for more of such examples). If such an extension of vernacular language could successfully occur, it would help students understand better the western mathematical concepts they are being asked to learn.

So far the researcher described the guidelines for using languages in mathematics lessons found in the syllabus and teachers' guides, formulated in response to the new language policy put in place by the government. The researcher refers to these documents as the 'Intended Curriculum'. In most cases, the reality of what happens in the classroom is not always the same as what is written in the intended curriculum. The researcher refers to the reality of the classroom language practices as the 'Implemented Curriculum', when the researcher reports on his own observations in Chapter 5 and 6. However, at this point it is useful to discuss briefly the research findings related to the implemented curriculum that explored the reality of using languages and their impacts on teaching and learning in PNG mathematics classrooms.

Searching through most popular international educational journals, there are very few studies reported that have focused on the impacts of language use on teaching and learning mathematics in multilingual classroom of Papua New Guinea. However there have been some. The discussion is divided in two: the first part comprises studies that emphasised the importance of fluency in English, and the second analysed the impacts of local vernacular in learning, both in a bi/multilingual environment.

First, there were a number of studies which clearly indicated that a student's command of English plays a role in his/her performance in the multilingual mathematics classroom. These studies include Souviney (1983) , Clements and Lean (1981), Meek and Feril (1978) and Jones (1982). Souviney (1983) tested students in grades 2, 4 and 6 with various mathematical language instruments, and on eight measures of cognitive development. From this study, it was concluded that as the mathematical tasks became more complex and hence the symbolic load increased, reliance on memory skills, in particular visual ones, were not adequate. The more successful students in higher grades were able to utilize their language abilities; the author assumes in particular those of English. Clements and Lean (1981) investigated various cultural, memory, spatial and mathematical variables in a cross-cultural study. This study included four community schools and an international primary school in Lae. The study found that there was no educational difference between PNG students and the mother-tongue English speaking students with memory tasks, but there were differences on some spatial tasks, on pencil- and-paper tests of mathematics and on a mathematical-language test. In particular, the authors found that PNG students handled word-free computational problems quite well, but with verbal arithmetic problems they had great difficulty. The authors thought this was the case because of the students' general difficulty with English, and especially with mathematical English. Similarly, Meek and Feril (1978) aimed to study the interrelatedness of English and mathematics achievement. The authors tested 171 grade-6 students on 11 mathematical words drawn from the grade-5 syllabus, and presented them in three different contexts. The test average was 44%, and only for one word item, more than one third of the students obtained correct answers in all three contexts. In addition, Johns (1982) investigated acquisition of the concept 'more-less' by students in grades 2-10. The result showed that PNG students were up to 4 years slower than their English speaking peers, even though they were taught at the same time. Twenty five percent of PNG students still had not mastered the indirect sub-construct by year 10. All of these studies concentrated on solving of mathematical word problems expressed in English, an internationally widely recognized area of difficulty for many pupils. These studies concentrated on the learners' fluency in English, but did not acknowledge the impacts of local vernacular that the students spoke fluently. As indicated in Chapter 2, I emphasised Cummins' bilingual theory that for bi/multilinguals to achieve better, they have to be balanced bilingual, but these studies emphasised only fluency of English. The following studies emphasis the fluency of local language and its impact when English as a second language is used as a language of instruction.

The second group of studies aimed at assessing the impacts of local vernacular language in learning within a bilingual mathematics classroom where English was used as a foreign language (Clarkson, 1983, 1991, 1992, 1994). Clarkson, working in urban community schools, assumed the students' first language was *Pidgin*, the language students used most frequently when outside of the classroom, although he acknowledged that most students were multilingual. The language of instruction was English. He administered language tests in both *Pidgin* and English. Clarkson concluded that the fluently spoken learner's language (*Pidgin*) played a vital role in learning mathematics. In addition, he also found that bilingual learners who were competent in both languages performed better than monolingual friends who were in the same class. Before this conclusion can be generalised for all 817 languages in Papua New Guinea, there is a need to study impacts of learning mathematics using a number of local vernacular languages. Historically, *Pidgin* was greatly influenced by English throughout its development, at the same time as French, Dutch, German and some local vernaculars of the Islands within which colonial masters had first contact. This similarity between *Pidgin* and English might be a factor in the children's higher performance in mathematics test.

Both the earlier studies emphasising fluency in English in solving word problems, and the later study on the impacts of local language first focused on learning mathematics, and, second, these studies were undertaken before the recent education reform, when English was the only language of instruction. This means that there have been no studies completed to understand the role played by local vernaculars, used either by learners in their learning or by teachers in their teaching in Papua New Guinea reported internationally, both before and after the new education reform. As noted in Chapter 2, there are some studies from South Africa that showed that the impact of the local vernacular language is significant in teaching mathematics within bilingual classrooms when English is used as a foreign language. These studies were carried out to assess the changes in classrooms after the language policy was implemented by the South African government in the mid-1990s, which allowed both teachers and students to use local vernaculars and English in the classroom situation. For example, the teachers used the local vernacular language to engage in an informal mathematics talk which enabled a successful shift to formal mathematical English (Setati & Adler, 2001). Such a technique, going from known to unknown mathematical language, was significant for successful learning. The study to be introduced in the next chapter focused on the impacts of local vernacular language on teaching within the bridging process of bilingual mathematics classroom. It assesses the impacts of using local vernacular language of the learners in teaching mathematics.

3.9 Summary

The Papua New Guinea education system has made a significant change in policy as to how language is to be used in classrooms, with emphasis still on English, but this time also on maintaining 800+ local languages. This change relates to the language of instruction in the first nine years of schooling. Under the new language policy, the language of instruction during the three years of elementary education will be strictly local vernacular. The lower and upper primary grades will involve bilingual education, with a specified amount of local vernaculars and English is to be used at each level. The first of the two languages will be one of the 817 local vernaculars, or one of the lingua franca (Pidgin or Motu). The other will be English. Generally, more of local vernacular is expected to be used than English at the lower primary sector, and at the upper primary, more of English is expected to take over from the local vernacular. Within the implementation of the language policy, there are a number of long term targets envisaged by the government of Papua New Guinea. First, it is aims at maintaining and preserving the 800 + local vernaculars of Papua New Guinea. Second, it was aimed at using the local language (home languages) as a resource or bridge to help teach English, in this case mathematical English. Third, while the local vernacular is used as a resource to teach mathematical English, the counter-effect will provide an opportunity for it to be developed linguistically. It is this third target which will be the core focus of the study the researcher now begins to outline in the following Chapter.

4.1 Introduction

This chapter outlines the methodology of the study reported in this thesis. The major aim of this study was to understand whether, how and why local language(s) were used in the teaching processes of some multilingual mathematics classrooms in the Wahgi area of Jiwaka Province in Papua New Guinea. In particular the following research questions were asked:

- What were the language contexts and practices found in grade 3 mathematics classes?
- What were the purposes of code-switching within mathematics teaching?
- What were teachers' perspectives on using the local languages and English in teaching?
- What were the roles of the local languages in teaching?

In order to do this, the study was guided by the concept of a case study, and in particular intrinsic case-study and multiple case-study approaches. Ethnographic methods of data collection were used. They were observations, interviews, field notes and questionnaires. The study involved eight local bridging-classroom (grade 3) teachers, who used *Wahgi*, *Pidgin* and English to teach mathematics. This chapter also describes strategies used to analyse the data. But before presenting a description of how data was collected and analysed, this chapter begins by outlining the conceptual frame work of case study that guided this study.

4.2 Conceptual Framework of a Case Study.

Case studies are a common way to do qualitative enquiry (Stake, 2005; Punch, 1998). Case study research is neither new nor essentially qualitative. According to Stake (2005), case study is not a methodological choice but a choice of what is to be studied. As a form of research, case study is defined by interest in individual cases, not by the methods of inquiry used. After identifying what is to be studied, the researcher could use whatever methods are deemed suitable to study the case (Stake, 2000; Punch, 1998). In the following section, a conceptual framework of case study used for this study is explored.

4.2.1 Issue and Context of the Study

As Stake (2005) indicated, a case study is carried out in order to address an issue. The issue to be addressed for this study was to understand how and why local languages are used in teaching mathematical English. The particular local language targeted in this study is *Wahgi* and *Pidgin*. According to Stake (2005), in most cases issues are located within a context. In other words, the case maybe singular, but it may have subsections, groups, occasions, dimensions and domain.

The issue addressed in this study was framed within a number of interrelated contexts. The first was related to the language context in the classroom, in which the role and reasons for using the local language could be studied. The language context was multilingual, the languages being *Wahgi*, *Pidgin* and English. The second context was also related to language-use, but in particular the role of the local language, *Wahgi*. The ways languages are to be used in the classroom environment as recommended at the policy level for Papua New Guinea (PNG) is for a bridging process to be used in the lower primary grades (3-5). This should involve the use of the fluently spoken local language(s) as a resource, aid, or to act as a bridge, to teach mathematical English. It was within this process that the study aimed to identify the different roles and the reasons for the use of *Wahgi*. Another important language practice, which is the third context, was related to the language-practice of code-switching. When the local language is to be used as resource to assist English use and learning, the speaker has to switch between English and the local language. The switching involves specific skills to switch appropriately for effective communication.

In summary, then, this research aimed to study the use of local language, as it unfolded through the teaching process within multilingual mathematics classrooms. This section (4.2.1) has outlined the context in which the main issue of the study is situated. The following section (4.2.2) identifies the boundaries that distinguish the case studied.

4.2.2 Boundaries of the Case

According to Stake (2005) a case maybe simple or complex, but it is commonly one among others in any given study. The case selected for this study was the individual teacher. However, not every teacher could be a case. As Stake (2005) indicated, if we are to study a case, it must be identifiable and found in a bounded system. The case should be recognized by certain features within the system, and other features outside the system, and the ensuing boundary between. In this study the teachers chosen as multiple cases for this study were within three major boundaries as shown in Figure 4.1.

First, teachers chosen as cases for this study taught within the linguistic land boundaries of *Wahgi*; specifically the South *Wahgi* dialect spoken in the Jiwaka Province of Papua New Guinea (see Map 4.2). This language boundary excluded the teachers found in other linguistic boundaries of Jiwaka Province and also the 800+ languages of Papua New Guinea. The boundary was defined by identifying tribal land boundaries that belongs to the speakers of South *Wahgi* dialect (details in section 4.3.1). Second, a teacher selected as a case for this study was someone teaching within a ‘rural bottom-up’ primary school. This meant that the teacher(s) who were teaching in community schools, ‘top-down’ primary schools and ‘urban bottom-up’ primary schools were excluded (details and definitions in section 4.3.2). Finally, a teacher that was teaching a grade 3 class was selected as a case for this study. Hence, the teachers who taught in rural-bottom up schools, but teaching in other grades (4-8) were not part of this study. In summary, each case selected was a teacher who was teaching grade 3 in a rural bottom-up primary school found within the linguistic boundary of South-*Wahgi* dialect in Jiwaka Province of Papua New Guinea.

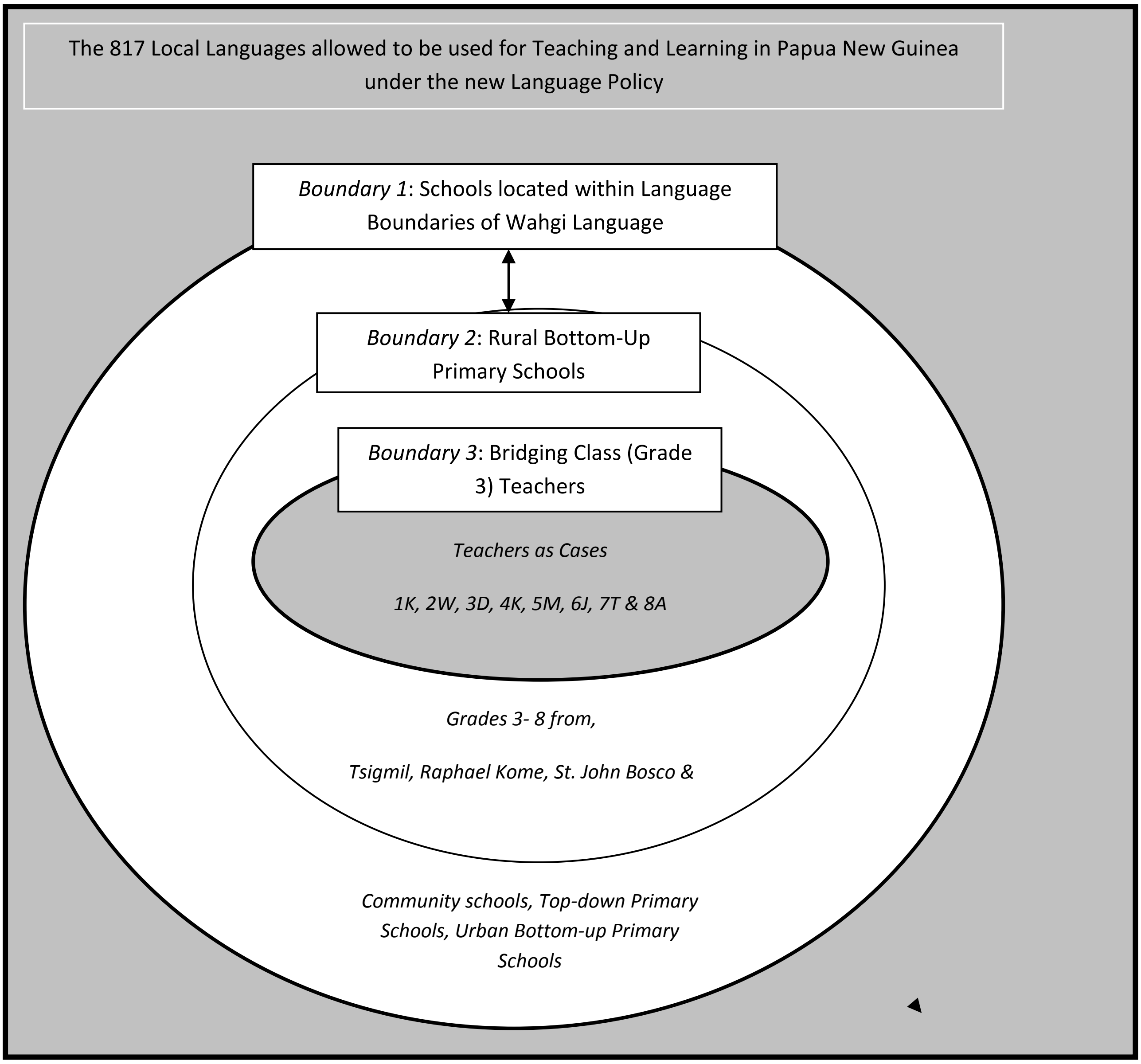

Figure 4.1. Boundaries Used to Identify and Select Case for this Study

Within these three major boundaries, a total population of eight teachers was identified and all of them were used as cases for this study. The following section identifies specific types of case study used in this study.

4.2.3 Types of Case Study

As Stake (2005) noted, a case study is about what is to be studied. The types of case studies are decided depending on the purpose of the overall project. As indicated earlier, the purpose of this study was to identify the role of *Wahgi* in multilingual mathematics classrooms, where *Pidgin* and English were also in use. However, this study had a deeper interest than just identifying the role of *Wahgi* use in mathematics classrooms. The role of *Wahgi* observed in a classroom situation was a linguistic behavior displayed by a teacher in a mathematics lesson. In other words, according to the teacher's thoughts and decision, when was *Wahgi* the best choice for a particular outcome? When was it that the other two available languages were judged to be not as effective for mathematics teaching in that moment? Since this study's major focus was on each teacher's reasoning and use of the *Wahgi* language, this study used the methods of an intrinsic case study (Stake, 2005).

Even though each of the eight teachers were studied individually for their own 'intrinsic purpose' as described earlier, there was also a need to study them together as a group. This need arose because the teachers included in this study represented a population of four rural bottom-up primary schools found within the linguistic boundaries of South *Wahgi* dialect. This could help identify and understand any common patterns and perspectives of language practice in 'rural bottom-up' primary schools in South *Wahgi* schools. The need to understand the 'commonness' required the study to also compare language-practices of the eight teachers, as if they constituted a single case. Therefore, this study also used the methods of a multiple case study (Stake, 2005).

In the earlier part of this section, a brief outline of boundaries in which cases were found was outlined. In the following section, detailed background information of each boundary is explored.

4.3 Background Information of Boundaries to the Case

Section 4.2.2 outlined briefly the boundaries of the cases. It was indicated that there were three ways the boundaries could be defined to locate the cases to be studied. The first, broader area was the language boundaries, the second was the type of schools the teachers taught in, and the third was that each case had to involve grade 3 teachers. This section provides more background information of each boundary within which the cases were situated.

4.3.1 Linguistic Boundaries of the Study Area

In Chapter 3 the researcher has indicated that Papua New Guinea is linguistically diverse and its citizens speak one of the 817 local vernacular languages, as well as one of the two lingua franca. In order to identify the study area, the researcher considered general language boundaries of two languages before specifying the schools and their participating teachers. The two languages are *Wahgi* and *Pidgin*. The *Wahgi* language is spoken by a specific group of people. *Pidgin* is a national language, spoken by almost all Papua New Guineans, including Wahgians. Therefore it was the language boundary of *Wahgi* that was considered, in order to identify the schools to include in this research.

Wahgi is one of the many languages spoken in the Jiwaka Province of Papua New Guinea. *Wahgi* has two known dialects; the South *Wahgi* dialect and the North *Wahgi* dialect (Muke, 2001). The language to be studied in this research project is the South *Wahgi* dialect, sometimes known as middle *Wahg*i (Mid-*Wahgi*) language. The locals refer to this language as *Yu Woi* (Muke, 1993; Burton, 1988). For this thesis, we will refer to it as South *Wahgi* dialect.

To locate linguistic land boundaries, the speakers are identified by their tribes. Hence, since land in the highlands part of Papua New Guinea is owned by tribal groups, the linguistic boundaries of *Wahgi* language is specified (see Figure 4.2). The South *Wahgi* language is spoken by almost 80,000 people, living in eighteen (18) tribes. These tribes are also part of a larger group. The technical term for this larger group is the ‘phratry group’ (Burton, 1988). According to Burton (1988), this term means a ‘set of brothers’ and more loosely could be thought of as an ‘original group’. There were four phratry groups; namely Anmblika, Dambnge, Kuma and Ngeneka (see Table 4.2). Figure 4.2 is a map locating *Wahgi*-speaking areas within Jiwaka Province and Papua New Guinea at large. Figure 4.3 shows in detail the tribal land boundaries of each tribe listed in Table 4.1.

Table 4.1.Tribes in phratry groups

Anmbilka	Dambnge	Kuma		Ngene
		True Kuma	***Others***	
Berepka	Kamblika	Aklimbka	Deimanka	Kusilka
	Kumnge	Kondika	Golekup	Muruka
	Kopanka	Konumbka	Komunka	Taka
	Tangilka	Kukika	Owika	
		Kurupka	Tuime Kup	
		Miamka		

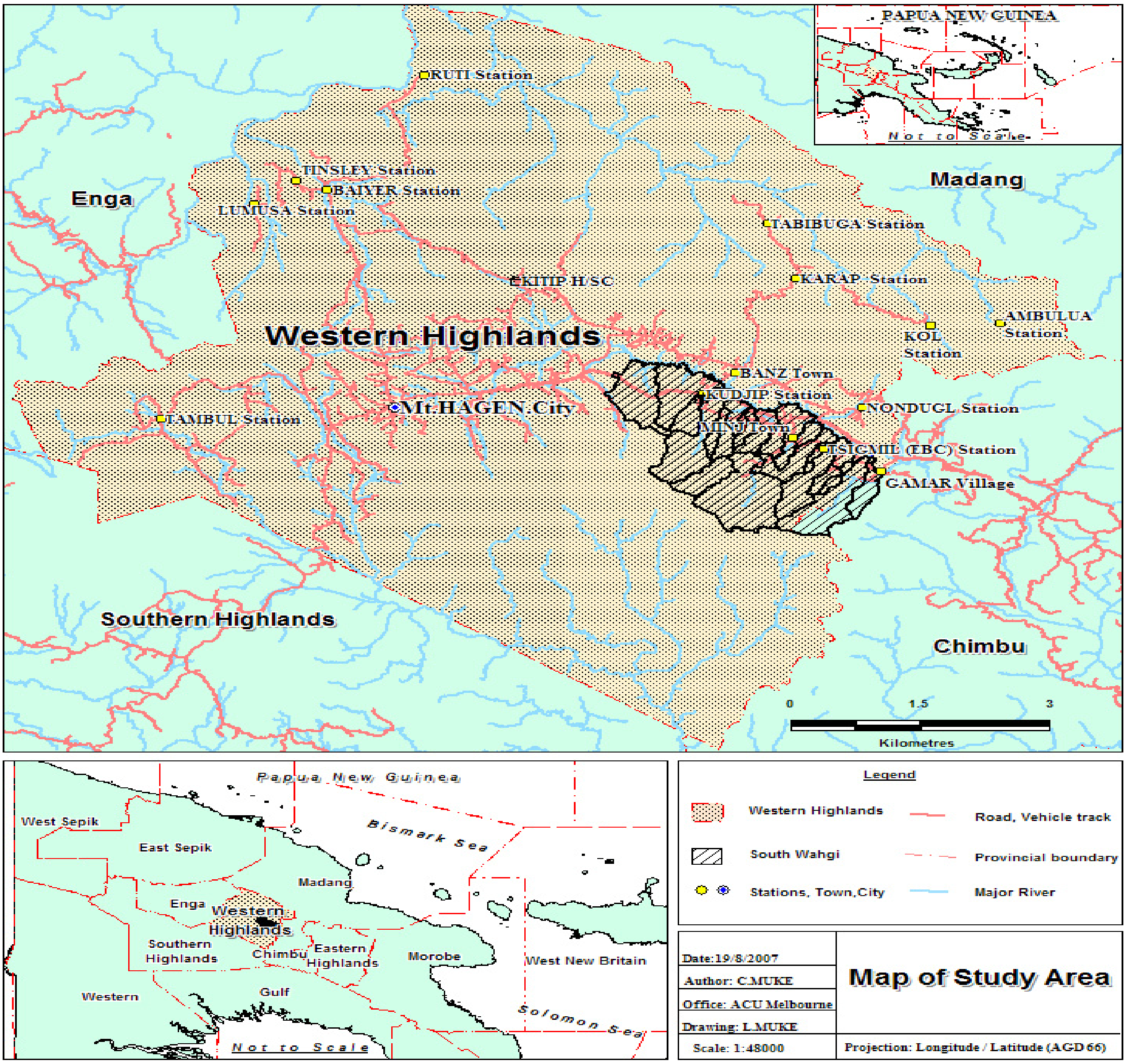

Figure 4.2. Map of Wahgi Speaking Locations of Jiwaka Province of Papua New Guinea.

From the East, the tribal boundaries of Gole Kup and Tuimekup of Kuma share borders with the Chimbu province (see Figure 4.2). The Tuman River serves as the major boundary to the west, for the Miamka, Kurupka and Ngene Takas share tribal boarders with the speakers of the Ek Nii language. To the south, the high mountains of Kubor range enclose the speakers of South *Wahgi*. On the other side of the ridges are the Kambi-speaking people of east Kambia. To the north, the major boundary follows the *Wahgi* River, and over the river are the speakers of North *Wahgi* dialect.

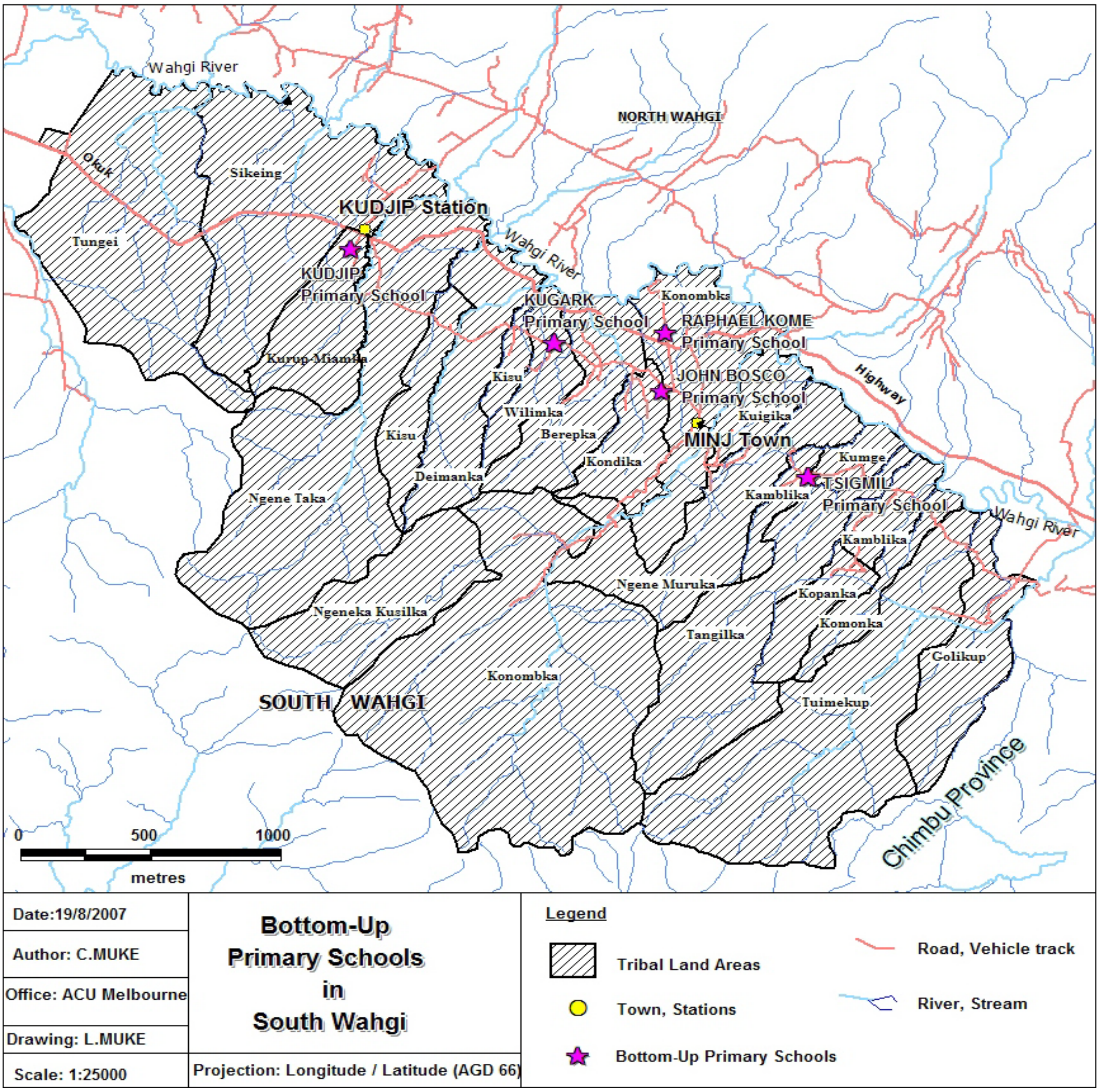

Figure 4. 3. South Wahgi Speaking Tribal Boundaries.

4.3.2 The Primary Schools Involved in the Study

This study focused on the primary schools located within the linguistic boundary of South *Wahgi* dialect (see Figure 4.3). Before the education reforms of 1992, all schools for children aged 7 to 13 were called ‘community schools’. During the recent education reform, some of these schools have been restructured and are now called ‘primary schools’. This study targeted primary schools. Due to the way these schools have been restructured, two categories of primary schools were identified. They were called ‘bottom-up’ and ‘top-down’ primary schools, which will be described in detail later. Those schools that have not yet been restructured are still called 'community schools'. Table 4.2 shows all the different types of schools found in South *Wahgi* area. The table indicates that there were 13 primary/community schools providing primary education to children from South *Wahgi* dialect speaking tribes.

The phrase 'bottom-up' and 'top-down' were used to describe the order of structural change to existing community schools under the recent education reform. It will be recalled from Chapter 3 that such changes began in community schools. One involved elementary grades, and the other dealt with grades 7 and 8. 'Bottom-up' schools are those that become linked to feeder elementary schools. The elementary schools consisted of three grades: preparatory (prep), grade 1 (E1) and grade 2 (E2). As the development of elementary schools took place, the new bottom-up primary school gradually deleted their grades 1 and 2, and then established grades 7 and 8. On the other hand, the 'top-down' primary schools began their structural change with establishing grades 7 and 8, but have yet to establish feeder elementary schools. Table 4.2 shows that seven community schools have undergone a restructure; five are bottom-up primary schools, and two are top-down primary schools. It is also clear that six schools have not gone through any change and still remain as community schools within the linguistic boundary of South *Wahgi*.

From Table 4.2, the schools that were bottom-up primary schools were further categorised as rural or urban schools. This category directly related to the location of the school and affected the use of a local language. If the schools were located near a township or had most students coming from families whose parents were working in the cash economy, that school was categorised as an urban primary school. The schools that were categorised as rural primary schools were far away from any township and had most children coming from families whose parents lived by subsistence farming. Those schools that were considered to be rural schools were expected by the new language policy to use the local language of the school as a resource for teaching and learning during the bridging process in a multilingual classroom. In this case, the *Wahgi* language was expected to be used in the bridging program. The schools that were considered urban, the local language was not expected to be used, but a more common language could be used.

Table 4.2. Schools found in South *Wahgi* Area.

Schools in South *Wahgi* Area	Type (Bottom-Up, Top Down Primary or Community School)	Area Category	Tribal Distribution per Phratry				
			Anbilka	Damnge	Kuma		Ngene
					True	Others	
Tsigmil	Bottom-up Primary	Rural		Kamblika Kumnge Tangilka Kopanka Komonka		Tuimikup Golekup	Muruka
Raphael Kome	Bottom-Up Primary	Rural	Berepk a		Konombka		
St. John Bosco	Bottom-Up Primary	Rural	Berepk a				
Kugark	Bottom-up Primary	Rural			Kurupka	Owika Deimankas	
Kudjip	Bottom-up Primary	Urban			Kurupka Miamka	Owika	Taka
Minj Tee	Top-Down Primary	Urban			Konombka Kondika Kukika		
Mondmil	Top Down Primary	Rural			Konombka Kondika		Kusilka
Jek	Community	Rural				Tuimekup Golekup	
Wara Numanj	Community	Rural		Tangilka Kpanka		Tuimekup	
Danal	Community	Rural		Kamblika		Komunka	
Kopong	Community	Rural		Kamblika	Kukika		Muruka
Tumbang	Community	Rural			Konomka Kondika		Kusilka
Piltange	Community	Rural			Miamka		Taka

In this case, *Pidgin* was the suitable language, as it was the national language. From the five bottom-up primary schools identified, four of the schools were rural-bottom up primary schools and only one was an urban bottom-up primary school. Since this study was focusing on *Wahgi* language as the basis for selecting schools to be included in this study, the urban bottom-up primary school was excluded. Hence, as noted in Table 4.2, the four rural bottom-up primary schools included in this study were Tsigmil, Raphael Kome, St. John Bosco and Kugark.

To reiterate, the main reason for selecting rural bottom-up primary schools is that these schools run bridging program for children who come from feeder elementary schools as described in Chapter 3. The language of instruction at the elementary schools was the local language (South *Wahgi*). Hence, in grade 3, in the four selected primary schools, teachers run bridging programs and, as expected by the language policy under the current education reform, teachers were to continue using local languages as a teaching resource to introduce mathematical English while mathematical content was taught.

It is within the bridging process in grade 3 in rural bottom-up primary schools that this study aims to understand the role of *Wahgi* while teaching mathematics lessons. Therefore the participants of this study are the teachers who were teaching in these schools. These participants are specifically identified per school in the following section.

4.3.3 Teacher Participants in the Study

The grade 3 teachers from the four rural bottom-up primary schools located within the language boundaries of South *Wahgi* were the main participants and were studied as cases for this research. Table 4.3 indicates that a total of eight teachers participated in this study. Teacher A taught in the same location in 2005 and 2006, and Teacher K for 2005, 2006 and 2007. Teachers D, G and T participated only in 2005 while Teachers W, M and J participated only in 2006. Due to the number of children, and also the availability of teachers, there was change in a number of grade 3 classes. Raphael Kome primary school had two grade 3 classes in 2005 but had only one grade 3 class in 2006. Similarly, St. John Bosco had one grade 3 class in 2005, but had two grade 3 classes in 2006.

Table 4.3. Teacher specification

Rural bottom-Up Primary Schools	**Participating Teachers: Within 3 years of Study; 2005, 2006 & 2007**			**Comments on Teachers**
	2005	**2006**	**2007**	
Tsigmil	K	K	K	
Raphael Kome	D	W		There was only one grade 3 class in 2006 due to no teacher. None of the teachers taught in 2005 remained in 2006.
	G	…		
St. John Bosco	T	M		One grade 3 in 2005 due to no teacher. Two new teachers in 2006. Teacher T was moved to upper grades
	…	J		
Kugark	A	A		

As indicated above, a case-study research is not a research method but it is about what is to be studied as described throughout this section. Therefore, this study used data collection techniques from ethnographic research design which are explored in the following sections.

4.3.4 Language Background of the Teachers

The major focus of this study was to identify the role of the local language(s), in particular *Wahgi,* in mathematics teaching. In order to identify the role of *Wahgi* in teaching, the teachers have to use the language in their teaching. According to the new language policy of Papua New Guinea, local teachers are to teach the bridging classes (grade 3), because the local vernacular used in elementary schools is expected to be used as a bridge to teach mathematical English in grade 3 (Mathematics - Lower Primary Syllabus 2004). Hence for teachers to participate as cases in this study, they had to be teaching within the *Wahgi* speaking area and also had to be fluent speakers of the language. Although anecdotal information established beforehand that all teachers to be study did speak *Wahgi* fluently, this was also confirmed during classroom observations. This took place in the beginning of the research as a preliminary study to identify suitable teachers to participate in this study. Table 4.4 shows the language used by each of the 8 teachers in each lesson that were observed. It is clear that all teachers used *Wahgi* language to teach most mathematics lessons. Two teachers did not use *Wahgi* in one of their lessons, but they used it in the other two lessons. Therefore, these teachers were local teachers and suitable candidates for participation in this study.

Table 4.4. Number of Languages per Lesson

Teachers	**Lesson**	**Languages Used in Mathematics Lessons**		
		1	**2**	**3**
K	1	Wahgi	Pidgin	English
	2	Wahgi	Pidgin	English
	3		Pidgin	English
W	1		Pidgin	English
	2	Wahgi	Pidgin	English
	3	Wahgi	Pidgin	English
	1	Wahgi	Pidgin	English
D	2	Wahgi	Pidgin	English
G	1	Wahgi	Pidgin	English
M	1	Wahgi	Pidgin	
	2	Wahgi	Pidgin	English
	3	Wahgi	Pidgin	English
J	1	Wahgi	Pidgin	English
	2	Wahgi	Pidgin	English
T	1	Wahgi	Pidgin	English
A	1	Wahgi	Pidgin	English

To be a local and speak *Wahgi* means you had to be part of a culture or tribe that speaks the language from birth or for a long time. A way to establish this fact was to identify the tribes the teaches belonged to from birth. The tribal origin of each teacher is shown on Table 4.5.

Table 4.5. Teachers and their Tribes

Schools	Teacher	Tribe
Tsigmil	K	Kamblika
Raphael Kome	W	Gnene Taka
	D	Konombka
	G	Deimanka
St. John Bosco	M	Kondika
	J	Konombka (Tau Kanem)
	T	Kondika
Kugark	A	Willimbka

Using the tribal land boundaries shown on Figure 4.2 and correlating it with the list of *Wahgi* speaking tribes on Table 4.2, Tsigmil Primary school was located in the tribal land of Kamblika. Therefore, Teacher K from the Kamblika tribe was a local teacher and was suitable to take up grade 3 at this school. Raphael Kome primary school was located within the land boundaries of Konombka tribe. Teacher W was a local teacher from the Konombka tribe. Teacher G and D were not from Konombka tribe, but as shown on the Figure 4.2 and Table 4.2, their Gnene Taka and Deimanka tribes were *Wahgi*-speaking tribes. Therefore, they were selected by the head teacher to teach grade 3, because they could speak *Wahgi,* as will be shown later. St John Bosco primary school was located on the tribal land of Kondika. Teacher M and T were from the Kondika tribe, and they were the locals at the schools. Teacher J was considered a local because he was from the neighbouring Konombka tribe. Since they were regarded as locals, they were appointed by their head teacher to teach grade 3. Kugark primary school was located on the tribal land of the Willimbka tribe. As shown on the Table 5.1, Teacher A was from that tribe, and he was a local teacher. He was a suitable candidate to teach grade 3 in this school. With this tribal background, it is clear that all the teachers were from the local tribe and therefore learnt to speak *Wahgi* since their childhood.

Being a *Wahgi* speaker is one thing, but using it for classroom processes requires a different language practice than those used outside of classroom. To understand how well a *Wahgi* speaker could use the language fluently for classroom practice, the experience of teaching within this linguistic boundary had to be established. As indicated in Chapter 3, the language policy has been very particular in how to use language in a grade 3 class. The experience of teachers in teaching grade 3 was an important factor to consider if we are to judge how well each teachers used the three languages for teaching mathematics. It would be proper to assume that those who had experience in teaching grade 3 would have established a better way of using languages to help them teach mathematics. Furthermore, they would have worked out how they would use languages, considering policy and their views of language use. In Chapters 5 and 6, these views will be discussed in detail. Here it useful to establish just how experienced in teaching each teacher was.

Table 4.6 shows the years the participating teachers taught as primary school teachers. There were three teachers who had 20 years or more of teaching experience. In addition, a couple of teachers had more than ten years of experience. Similarly, two teachers had more than 5 years of teaching experience. Only one teacher had less than five years of teaching experience. An inspection of Table 4.6 shows that most teachers were experienced teachers.

This study also went further to investigate how experienced these teachers were in teaching grade 3 classes. From Table 4.6, those teacher that had less than 10 years' experience had not taught grade 3 in the previous years, but it was their first time teaching grade 3 in 2005. On the other hand, teachers who taught more than ten years indicated that they had some experience of teaching grade 3 classes in the past. When comparing the number of years these teachers taught grade 3 classes, Teacher K indicated that she had seven years'experience of grade three teaching, Teacher A indicated that he had five years' experience of teaching grade 3, Teacher T indicated that she had three years' experience of grade 3 class teaching and Teachers D and M indicated that they had two years' experience each of teaching grade 3 class. It was the first time teaching grade 3 for Teachers W, G and J.

Table 4.6. Teaching Experience of the Eight Cases

Teacher	Years of Teaching up to 2005	Grades taught last 10 years									
		2004	**2003**	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**	**1995**
K	20	3	3	4	3	2	1	3	3	3	3
W	3	7,8	7, 8	6							
D	14	3	6	6	6	4	3	1	6	5	4
K	6	6	7, 8	7, 8	7, 8	6					
M	26	1	2	2	4	4	2	3		5	3
J	6	7, 8	7, 8	6	5	6	6				
T	16	3	5	3	6	3	6	4	6	5	6
A	24	3	3	3	3	1	2	1	3	4	5

4.3.5 Students' Language Backgrounds

In the earlier sections (4.3.1-4.3.4), the details of teachers' language backgrounds were described. Since this study did not target students, therefore the details of students' language backgrounds was not the focus of this study. However, a brief observation and survey was carried out to understand the language-use at the feeder elementary schools of the four primary schools involved in this study and the language background of students in grade 3 classes that were taught by teachers observed through this study. Briefly, most students attending the feeder Elementary schools were from the *Wahg*-speaking tribes living around the school. Therefore, the languages of teaching and learning at the feeder elementary schools were *Wahgi.* At the same time, it was also common for a second local language to be used at the elementary schools as the language for teaching and learning, and that was *Pidgin*, the national language of Papua New Guinea. It was obvious that parents allowed their children to learn both *Wahgi* to communicate within their cultural group and *Pidgin* to communicate with people from other cultural group in PNG. Therefore, with the consent of the parents, both *Wahgi* and *Pidgin* were allowed to be used for teaching and learning in elementary schooling. In addition, this study also found that most grade 3 students, who were taught by teachers selected for this study, were fluent speakers of both *Wahgi* and *Pidgin*. In addition, a few students in grade 3 were foreigners and could be communicated with only by using

Pidgin. Therefore, it will be shown in chapters 5 and 6 that teachers frequently used *Pidgin* for both groups of students but occasionally used *Wahgi* when local-language students showed misunderstanding, as a resource to introduce mathematical English and mathematics content expressed in English.

4.4 Ethnographic Research Design

The ethnographic style of field research was developed originally by anthropologists who wished to study a society or some aspects of a society, a culture, or some other type of group in depth (Bell, 1993). Such a design is no longer restricted to anthropology, but is employed in other fields, including educational research. This study used the ethnographic approach. As Crabtree and Miller (1999) noted, ethnographers aim to learn about a situation in basically three ways: (1) observation – what people actually do, as well as examination of artefacts of any sort; (2) discussion – what people say they think, believe, or do, and why; and (3) reflection – what the ethnographer infers or interprets. In this case, the situation is the multilingual mathematics classrooms in which *Wahgi* is used in conjunction with *Pidgin* and English. To learn about the role of each language in such a classroom situation, the study used these three ways. The first was observation, where the researcher listened, recorded and took notes of available languages used in mathematics teaching. The second involved questionnaires and interviews, to gain an understanding of the cases' backgrounds, to discuss their thoughts, beliefs, and the reasons behind the teachers' use, or not, of Wahgi in their mathematics teaching. The third involved the researcher's abilities and skills to infer and interpret the data collected, but also his awareness of how these data related to the relevant research literature. One of the major factors was the ethnographer's long-term experience and observations. As indicated in Chapter 1, the researcher was a local and a former teacher in the location, and this played a vital role in the quality of the processes of inference and interpretation involved throughout this study. The reader is left to judge how effective this process proved and the quality of the subsequent report.

The following section describes the techniques used to observe the teachers and discuss with them the issues central to this study.

4.4.1 Passive Participant Observation

As indicated earlier, one of the ways of completing an ethnographic study is through observation. As Crabtree and Miller (1999) indicated, this involves observing what people do. In this study the people concerned were the teachers, and the activity that was of interest was their use of three languages in mathematics teaching. As an ethnographer, the researcher should undertake both long-term and short-term observations. In an earlier section, the researcher's background was discussed to clarify that, as a researcher, he was a local and he had also been a teacher who had taught in the schools within *Wahgi* area for some time. In this way, he has been a long-term observer of classrooms and language-use in the schools studied here. In this section, he will discuss the short-term observation undertaken to collect data to understand the role of languages in teaching mathematics.

The style of observation involved the researcher sitting at the back of the classroom, observing and listening to the talk of the teacher in his/her mathematics teaching. The need for the researcher to participate actively was very minimal in the classroom situation. Therefore, the researcher was engaged in a non-participant or passive participant observation (Spradley, 1980). As Spradley said, as a passive participant observer, the researcher's position in the classroom was that of a bystander, spectator or loiterer in the overall classroom process.

Initially, the researcher planned to observe three lessons per teacher, each lesson at a different time of each year, in 2005 and 2006. This was to understand how much of each language was used at the beginning, middle and end of the year, throughout the bridging program in grade 3. However, as Table 4.5 shows, there was a significant difference in the number of lessons observed. There were a number of events that occurred beyond the researcher's control that hindered the plan. First, there was limited funding for this research. Therefore, the researcher took up part-time employment, at the University of Goroka in Papua New Guinea. This in turn posed a number of additional problems related to timing and movement. The researcher's days of data collection were restricted to a two per week. In addition, since the university was located about 550 km away from the study area, the researcher's movement to and fro posed an extra challenge. Some of the schools were located in remote areas, far from any highway. The researcher's only transport was by buses that ran to no reliable schedule. Hence it was always problematic to reach the school before the teacher had started a mathematics lesson. In addition there was considerable teacher movement. Either they left school, were elevated to higher grades, did not come to school, or were attending in-service programmes. Furthermore, the researcher also had problems with a power source for my recording equipment (see later). In some schools electricity was not available. At times generators that the researcher has hired broke down. These are some of the many reasons that played a significant part in making it impossible for the researcher to collect data as consistently as planned. Similarly, situations that have an impact on consistent data collection in developing countries are recorded in the literature (Vithal, 2004). Table 4.7 gives a summary of the data collection.

During the periods of observation, the researcher used three data-collection techniques. First, he kept field notes. Although limited in their use, paper and pen notes are easily obtained. A detailed record of what was being said was made with audio and video recordings, but taking notes of significant events and making insightful comments on the spot are of themselves important for the ethnographer. In addition, the field notes were also used to generate and write questions as a lesson unfolded, which were used later when interviewing the teacher. Making up questions on the spot as teaching took place was an excellent way to help gain insights and meanings to some of the behaviours of the teachers in the actual teaching practice. Furthermore, given the difficulties of using the technologies where electricity was never easily available, and the possibilities of running out of batteries with no nearby store for new ones, was an ever present difficulty. Keeping field notes was by far the most reliable method of data collection for this study.

Since the role of languages could be identified through the talk of teachers in their mathematics teaching, recording every word used by the teacher was important. Obviously field notes cannot do that, and the researcher could not memorise everything the teacher said in a lesson. Therefore, the researcher's second sources of data were video and audio recordings. In fact, video recording proved to be by far the better data source, but due to the uncertainties of electricity supply it was prudent to also make an audio recording as a backup.

Table 4.7. List of Lessons Observed per Teacher.

Rural Bottom-Up Primary Schools	Teacher Participants	Number of Lessons	Lesson Dates		
			2005	2006	2007
Tsigmil	K	1	05/05/05		
		2		07/06/06	
		3			19/04/07
Raphael Kome	W	1		21/03/06	
		2		22/03/06	
		3		22/08/06	
	D	1	06/05/05		
		2	24/10/05		
	G	1	08/05/05		
St. John Bosco	M	1		20/03/06	
		2		21/03/06	
		3		28/08/06	
	J	1		20/03/06	
		2		21/03/06	
	T	1	27/05/05		
Kugark	A	1	25/10/06		
	Total Lessons	**16**	**6**	**9**	**1**

The video recording did not only record sound of the talk in the teaching, but served other purposes. First, it provided visual data that could be needed later in the data analysis. Second, the video recording was also used during the interview. The teachers were given the opportunity to see their own teaching as the interview proceeded to help their memory to why they behaved the way they did linguistically. However, the audio recorder was used as a backup due for a number of reasons. First, the researcher had access to a video recorder that could only use mains-power as its battery system was not working. Being a local researcher, he was aware that all schools would not have power; therefore a small audio recorder which could be run on batteries was handy. Secondly, the video recorder was a very old machine and it played up some times. Therefore, to be on the safe side, the researcher ran an audio tape together with the video recording. Third, the video recorder was positioned at one place at the back of the room. To avoid losing any sound while the teacher moved around to attend to children, an audio recorder became handy. The audio recorder was small and the teacher was able to carry it around as he/she was attending to students individually. Apart from using the audio recorder as a backup tool, it was also used to record the interviews that the researcher carried out with teachers to gain insights into opinions, beliefs and reasons related to using or not using *Wahgi* language in mathematics teaching.

4.4.2 Data Collection through Semi-Structured Interview

This study used interviews as another means of collecting data. As Burns (1997) said, an interview is a verbal interchange, often face-to-face, in which the interviewer tries to elicit information, beliefs or opinions from another person, in this case the teachers. According to Cohen and Manion (1994), interviews could be categorized as unstructured, which are like normal conversation; semi-structured, which have a few leading questions; and structured, which have precise list of questions. This study used semi-structured interviews.

The researcher's preference was to carry out the interview straight after the lesson. Since the interview was about how the teacher used language in that lesson, the closer the interview was to the lesson, the more confident one could be that and the teacher's memory of their teaching was still fresh. However, in the cases that the researcher could not carry out an interview straight after the lesson, the researcher organised a TV screen so that he and the teacher could replay the video recording of the lesson, or aspects of it that the teacher thought were important. The specification of the interview is shown on Table 4.8. A comparison of Tables 4.7 and 4.8 will show that because of the difficulties with recording, a number of the planned interviews did not take place.

Table 4.8. The Interview Specification Table.

Primary School	Teacher	Date	
		Without TV	With TV
Tsigmil	K	07/06/06	
Raphael Kome	W	22/03/08	
			22/08/06
St. John Bosco	M		28/06/06
		21/03/06*	
	J	21/03/06*	
Kugark	A		25/08/06

*They were interviewed together on the 21/03/06

Since it was a semi-structured interview, the leading questions were related to teaching episodes observed during the lesson. The questions were prepared while taking field notes during each lesson. Further questions were added as the conversation progressed. Some of the leading questions used were:

- Why did you use *Wahgi/Pidgin* language in this part of the lesson?
- Why is that you did not use *Wahgi* in this part of the lesson?
- Is there any other area you could use *Wahgi*?
- It seems you used a lot of *Wahgi* in your lesson, why?
- It seems that you used a lot of English in your lesson, why?
- It seems you used a lot of *Pidgin*, why?

4.4.3 Questionnaires

A simple questionnaire (see Appendix B) was used to gain background information about each teacher. These data included linguistic background by identifying tribal membership, number of years teaching experience, and how many languages they used in their class. The teachers were also asked briefly for their opinion on using different languages in teaching. The reasons for gaining information on each teacher's linguistic background, and their perception of language use in classrooms are self-evident. The reason for asking about their length of teaching experience was prompted by a belief that teachers who have been teaching for something like five years or more, and hence are beyond being classified as beginning teachers, maybe more likely to use and be more comfortable with their multiple languages, and to know why they do so.

So far, the researcher has described the methods of data collection. In the following section, how these data were analysed is described.

4.5 Data Analysis Procedures

The guides to choosing the techniques of data analysis were the research questions. As Yin (2009) indicated, just as research questions assist in shaping a data collection plan, in a similar way they enable a study such as this one to set priorities for the relevant analytical strategies. As indicated in chapter 1, the central focus of this study was to investigate the role of local language in a multilingual mathematical teaching context. There were three supporting questions. The four questions that guided both the data collection and data analysis are again listed below.

- What were the language context and practices found in grade 3 mathematics classes?
- What were the purposes of code-switching within mathematics teaching?
- What were teachers' perspectives of using the local languages and English in teaching?
- What were the roles of the local languages in teaching?

The description of data analysis will use the research questions as a structuring device.

4.5.1 What were the language contexts and practices found in grade 3 mathematics classes?

As indicated earlier, the main research question was to identify the role of local language in teaching mathematics. The role of local language to be determined, from the perspective of the new language policy, was within a bilingual context, where the local language was to be used as a resource to introduce English. Therefore, this study needed to confirm the exact language-context and language-practices used, before the role of local language could be determined. Therefore, this study established the first research question as: What were the language context and practices found in grade 3 mathematics classes?

During the study, it was obvious that teachers used more than one language in their teaching. As part of data analysis, this study needed to identify which languages and how many were used for teaching in a single mathematics lesson. Therefore, this study needed to identify the number of languages used by teachers who participated in this study in each of their lessons to determine if the classroom was monolingual (one language use), bilingual (two language use) or multilingual (more than two language use). By listening to both video and audio recordings, reading the transcript of teaching by eight teachers and using field notes, this study was able to determine the classroom language context. It will be shown in Chapter 5 and 6, that most mathematics classrooms were multilingual and teachers used three languages for teaching; including *Wahgi, Pidgin* and English.

This study went further to determine how much each of these three languages were used within a single mathematics lesson, and such results could be used to assess the implementation of the new language policy, which suggested the use of 60% of local language(s) and 40% of English. To describe how much each language was spoken in a mathematics lesson, a quantitative method of data analysis was used. This involved the counting of words from each language. The application used to carry out this analysis was the

‘Microsoft word-count’ tool. The word-count was done per lesson for each of the three languages. Using subtotals from each language and the overall total of the lesson, the amount of talk in each language was converted into a percentage. The results were presented on a table.

As indicated earlier, *Wahgi* was used in a mixture with *Pidgin* and English in the same lesson to teach mathematics. Since there was more than one language in use in teaching, this study also aimed to distinguish if the language-practice of code-switching was taking place. Therefore, the data analysis also aimed to confirm the language-practice of code-switching that was taking place within the talk of the teachers in their classroom practice. The first stage of the analysis involved reading through the teaching transcripts of the 16 lessons, spotting the language-practice of code-switching and counting each one of them in each lesson. This was put in a table with labels such as ‘switching off’ (for the language used before the switch) and ‘switching to’ (for the language alternated). Such counting was conducted so that a common language-pairing could be distinguished. A common language-pairing was identified if the count of switches between two languages were almost even. It will be shown in Chapters 5 and 6 that the common pairing was between *Pidgin* and English.

As indicated earlier, the main target of this study was to determine the role of the local language within mathematics teaching. Since the local language was used in teaching, there are other ways the role of local language could be determined. But this study aimed to distinguish the role of local language through the language-practices of code-switching. As part of data analysis to answer the main research question, this study targeted the purpose of code-switching to determine the role of local languages as they were alternated during teaching process. Therefore, the following section examines what analysis was done to determine the purpose of code-switching.

4.5.2 What were the purposes of code-switching within mathematics teaching?

This section addresses data-analysis related to question 2: What were the purposes of code-switching within mathematics teaching? This question was, in fact, seeking an answer from two sources of data-analysis; one will be addressed here and the other is addressed in discussing question 3. These areas are related to teachers' perspectives and teaching practices that involved code-switching.

To determine the purpose of code-switching, the how- and why-questions were asked while examining the practices of code-switching used within teaching process. The how question was asked during data-analysis to distinguish the types of code-switching the teachers were engaged in and the ways talking was conducted using these types of code-switching. It started with a search for types of code-switching already known through other studies reported in Chapter 2. The types that guided this data analysis were the types reported by Skiba (1997) as inter-sentential switching (switching occurred between sentences) and intra-sentential switching (code-switching that occurred within a sentence) (see Figure 4.4). Code-switching within sentences was further described by Setati and Adler (2001) as code-borrowing and code-mixing.

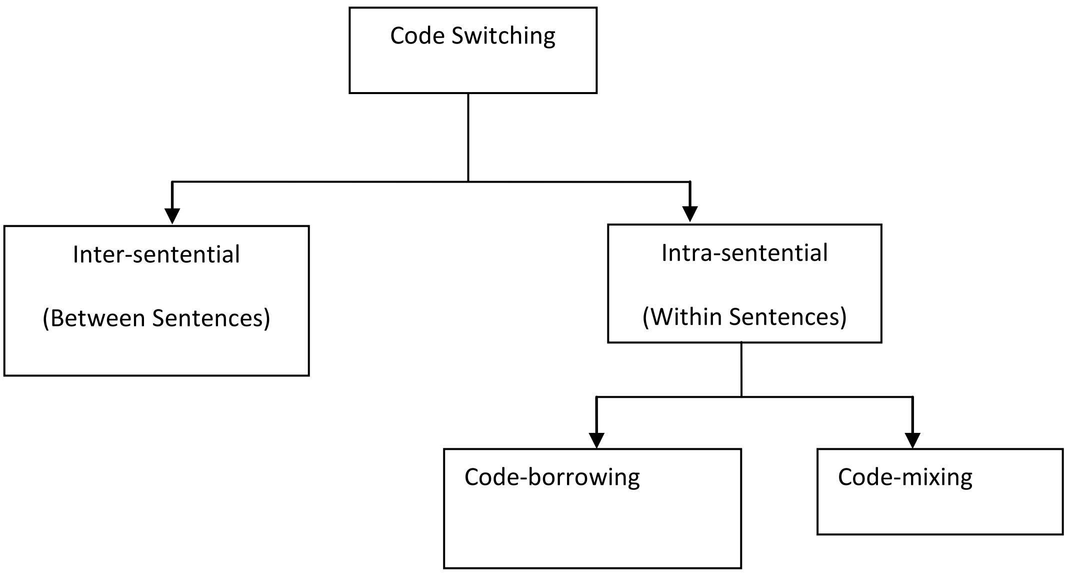

Figure 4.4. Types of Code-Switching to be identified.

Analysing ways of talking that used code-switching very much related to the why-question that would help determine the purpose of code-switching. The analysis of this study began with intra-sentential switching, particularly code-borrowing. This started with a term or phrase very much in a mathematics register borrowed into a sentence constructed in another language. This involved distinguishing the terms or phrases and in what language they were expressed. It also involved distinguishing the language in which the rest of the sentence was constructed. Then a comparison was made to see which language was commonly used to expressed the mathematics register and which language was commonly used to construct the overall sentence. To determine the purpose of code-borrowing, this study needed to examine how these terms and phrases were used within the grammatical rule of sentence-construction. This analysis aimed to understand whether the term or phrase borrowed was used as a noun phrase or a verb phrase within the sentence structure. Figure 4.5 shows a general sentencestructure which the analysis used as a guide to locate where the borrowed terms or phrases were commonly located within the sentence.

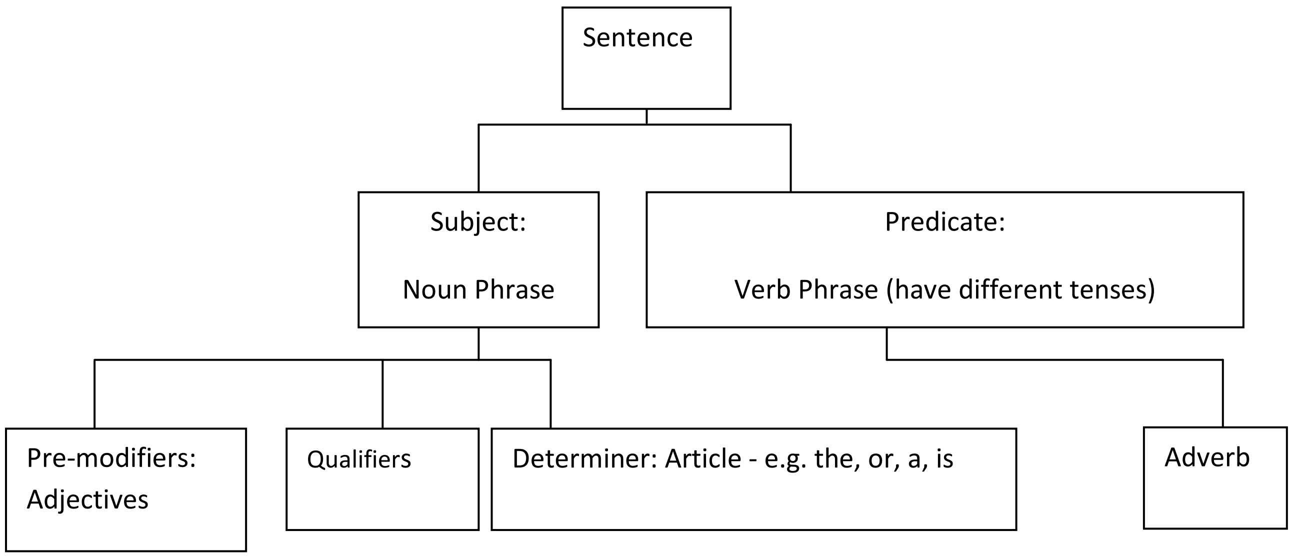

Figure 4.5. Coding Sentence Parts.

As shown in Figure 4.5, a sentence generally consists of two main parts, a noun phrase and a verb-form phrase. Generally the noun in the noun-phrase is regarded as the ‘head word’ and the verb, if active, names the action performed by the noun. In other words, the most significant semantic content of the sentence is carried by the noun-forms. With this knowledge, this analysis aimed to locate the borrowed terms or phrases within the overall sentence-structure constructed in each language. This will then help distinguish the purpose of the language practice of code-borrowing or code-mixing.

The code-borrowings that took place between sentences were also analysed. This involved identifying what ways of talking teachers were engaged in after code-switching and using the local language. Using ways of talking that other studies found common (Mercer, 1995: Setati & Adler, 2001), the researcher looked for examples of questioning, explaining, making statements, instructing, repeating (questions, explanations, instructions), etc. These ways of talking help summarise the purpose of code-switching. Consequently, through focusing on the purpose of code-switching, this helped identify the role of local language while used as an alternated language which will be discussed in sub-section 4.5.4.

Another process that was taking place simultaneously was the emphasis teachers put on ways of talking that used the local language as an alternate language. In identifying these episodes it was hoped the researcher could establish for which part of the discourse in the mathematics lesson local languages were commonly used. This will help determine the purpose of code-switching that involved the use of local languages. The guide used is shown on Figure 4.6.

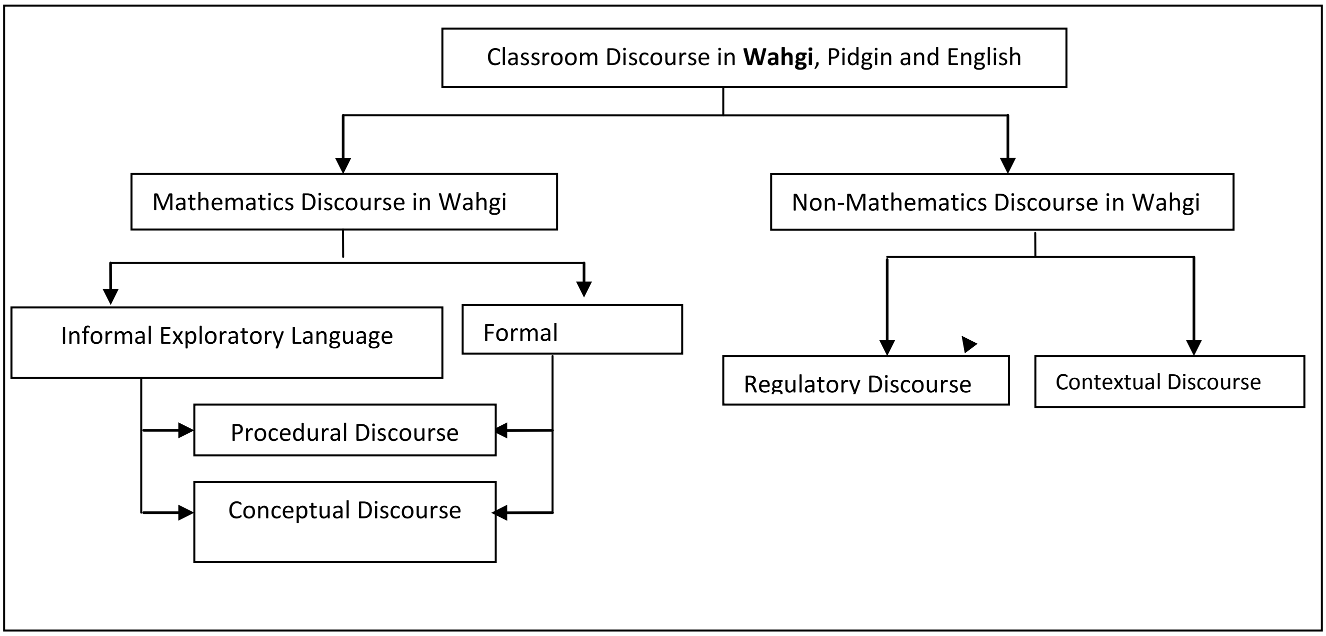

Figure 4.6. Public Discourses in Mathematics Classrooms initiated by the Teacher.

It will be recalled that in Chapter 2 (repeated in Figure 4.6), reference was made to the analysis Setati and Adler (2001) used in South Africa. These categories were used in this analysis.

The teachers' entire verbal communications and their supposed purposes were listed. This list of utterances was then divided into two groups: mathematical discourse and non-mathematical discourse. Those sentences that were classified as mathematical discourse were further grouped as informal or formal language. Then they were classified as procedural or conceptual discourse. Similarly, sentences classified as non-mathematical discourse were also categorised as regulatory or contextual discourse. The aim of such a grouping of sentences/paragraphs from each language in each of this discourse was to locate the use of different languages in the mix in the overall classroom discourse in a mathematics lesson. This will then give an in-depth picture of the kinds of purposes of the code-switching that was taking place using each language, and also the role of each language in teaching mathematics lessons. The particular target of this study was to determine the quality of language use and the skills of code-switching, particularly in the mathematical discourse. The aim was to examine how and why local languages were used within the procedural discourse and conceptual discourse of a mathematics lesson. In the event of such process, the roles of local language could be determined. Chapter 5 and 6 present such results.

This section discussed how analysis took place with data obtained from teaching process that involved code-switching to determine the purpose of the language practice. This study also aimed to confirm this practice with teachers' perspectives relating to this language practice. This desire stimulated the third question and the analysis related to this question is described in the following section.

4.5.3 What were teachers' perspectives of using the local languages and English in teaching?

The third research question was '**What were teachers' perspectives of using the local languages and English in teaching?' As indicated earlier, the method of collecting data to understand teacher's perspective about language-use in the mathematics classroom was through semi-structured interviews. These were recorded on audio tapes. As part of the data-analysis, the researcher transcribed the seven interviews that were carried out for this study (see Table 4.8). The transcripts were analysed by specifically searching for the reasons and views of teachers that explained why they did or did not used code-switching and alternated Wahgi to teach mathematics, and what ways they nuanced their reasoning. The result helped to confirm the purpose of code-switching, they displayed through their teaching practices.

4.5.4. What were the roles of the local languages in teaching?

The fourth and the main research question asked in this study was‘What were the roles of the local languages in teaching?’ The results summarized as the purpose of code-switching and perspectives of teachers related to alternating local language have highlighted the roles of local languages. The analysis to determine the role of local language examined how they were used in the language practice of code-borrowing, to ask questions, explain and repeat.

4.5.5 Analysing Teacher K’s Teaching

What the author has described so far is the data-analysis techniques used for the eight teachers whose lessons were observed. However, as the analyses proceeded it became clear that one teacher in particular used each language, including Wahgi, effectively to teach mathematics. It was decided that it would enrich the results if she was selected as a specific case to analyse.

The teacher selected as was ‘Teacher K’ from Tsigmil primary school. To compare her languag-use with that of other teachers in detail, each lesson taught by the eight teachers was analysed in detail as given diagrammatically in Figure 4.7.

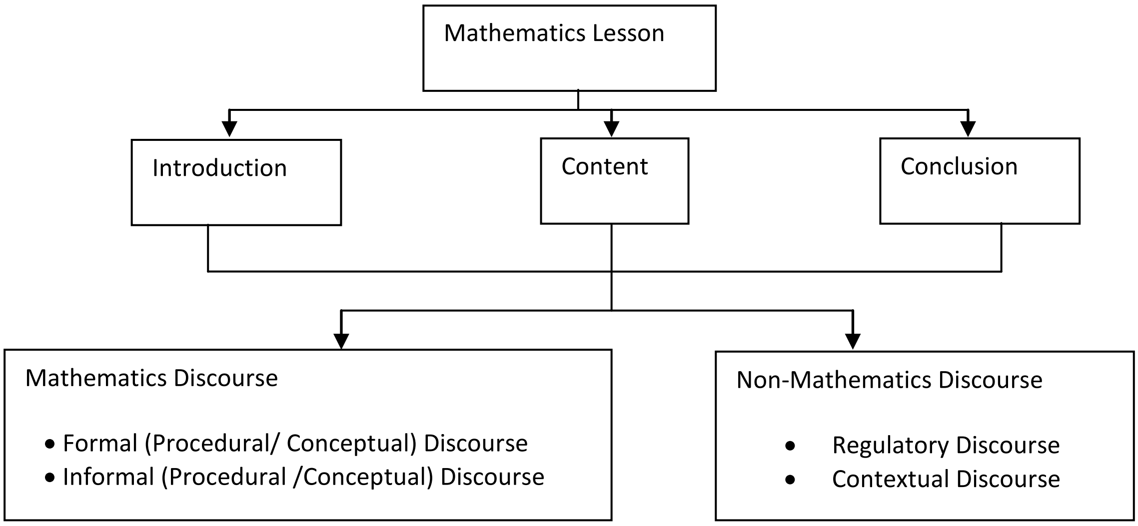

Figure 4.7. Lesson Parts and Discourse in Teacher K's Mathematics Lessons.

The researcher broke each lesson into three sections to enable effective analysis and compare with other teachers's practice. The three sections of each lesson were introduction, content and conclusion. The analysis aimed to distinguish what was mainly done for each lessons parts, but a particular interest was to see which language was used commonly and how code-switching was conducted in each sections of the lesson. The aim was to determine the purpose of code-switching and determine the role of local languages in each of these sections. The use of local languages in each section of the lesson was further analysed to understand whether it was used for mathematical discourse or non-mathematical discourse. The amount of Wahgi used was also a major point of analysis, which was related to her perspectives about using Wahgi and other languages. Therefore, her interview was also analysed to understand more fully her main reasons for using or not using Wahgi within her teaching.

So far the researcher has described both data-collection and analysis processes. The following section describes the evaluation criteria that allow judgment to be made on how effective the data collection and analysis process were.

4.6 Evaluation Criteria

Bailey (2007) indicated that qualitative researchers, as well as quantitative researchers, must answer questions about the triangulation, validity, reliability and generalizability of their work. The following sections aim to answer some questions related to these areas of evaluation of both data-collection and analysis used in this study.

4.6.1 Triangulation

The main purpose of triangulation is to ensure the quality of field research (Bailey, 2007). There are a number of ways a study can be triangulated to determine quality data-collection and analysis. To illustrate, this section briefly describes how this study triangulated data collection and analysis processes.

As Bailey (2007) noted, one of the forms of triangulation is by using multiple methods of data-collection. To triangulate the data-collection process of this study, a number of methods were used. The main method of data collection was through passive participant lesson observation, but certain techniques and tools were used to assist collecting quality data. These included field notes, audio/video recordings, carrying out interviews about the observation, and administering questionnaires.

As an illustration of triangulation in this study, the researcher shows how different types of data were interleaved. In the field notes I estimated how much each language was used per lesson after listening to the teacher's talk. Remembering the researcher was a fluent speaker in all languages used in the classroom, the researcher used measuring terms such as, 'mostly used', 'medium use' and 'less used' in my notes. This estimated claim was later confirmed by counting all the words on the transcriptions of the classroom talk recorded on audio/video tapes. The amount of language use in each language was expressed in percentages. Similarly, through subjectively identifying the role of *Wahgi* during classroom observations, the researcher could roughly work out the reason why the teacher might have used Wahgi. But to get another representation of the teacher's perspective and reasoning, an interview was conducted. In addition, how fluently the languages were used as observed and recorded on the audio/video tapes could be related to the language background, tribal origin and teaching experience, which were gathered through questionnaires. The description of a few complementary research techniques discussed here is to illustrate how the use of different techniques used in a coordinated way lead to obtaining quality data for this study. As Bailey (2007) noted, using more than one technique of collecting data in such a way as describes here, answers questions related to triangulation for this study.

4.6.2 Validity and Trustworthiness

According to Bailey (2007), validity refers to studying or measuring that which one intended to study or measure. In place of validity, some researchers, particularly those who use an interpretive paradigm, substitute the concept of trustworthiness as the overarching evaluative standard for field research. Trustworthiness requires conducting and presenting the research in such a way that the reader can believe, or trust, the results and be convinced that the research is worthy of his or her attention (Bailey, 2007). To achieve trustworthiness, he or she must, at a minimum, communicate in detail the procedures used and decisions made throughout the research process. This has been done in this methodology chapter, and in Chapters 2 and 3. Two further factors attest to the validity and trustworthiness of conclusion made through this study. They are related to the research methods selected, and the researcher's background.

Firstly, there was a fundamental reason why the researcher decided to use case-study as the research design, and ethnographic techniques for data collection. It has been shown that, in the relevant research literature (Chapters 2 and 3), study of the role of a fluently spoken local language in aiding English in a mathematics teaching situation was rare. Therefore, to gain a detailed and in-depth perspective about such a phenomenon, the researcher needed to study a case or cases in 'natural' mathematics classrooms. Due to the relative lack of international studies, there was no one suitable theoretical framework to use to guide this study. Therefore, to minimise the risk of interfering in the natural use of language in a mathematics classroom situation, the researcher decided to become a passive (non-active) observer during data collection, assisted by audio/video technologies to record every word of a teacher in his/her teaching, so that data could be used later when needed.

Second, to be a better ethnographer for this study, the researcher needed to have lived in the study area for a long time, speak the languages, have experience of being a multilingual, and must be an experienced code-switching teacher in a multilingual mathematics classroom. The researcher's background was described in detail in Chapter 1 to show the reader that he was no ordinary ethnographer; but someone studying his own culture, language and former workplace in which he spent most of his life. In addition, such a background assisted the researcher in making informed judgements throughout this study, during both data collection and the analysing process. This included pre-selection of cases by the use of the language after the first observation, the ability to recognise instantly the purposeful use of the different languages throughout the lessons and the reasons for making the decisions to use different languages to teach. Using such skills to assess the data collection and analysis serves to heighten the internal validity and trustworthiness of the study processes. The researcher of this study aimed to achieve internal validity by using his life-experiences to help establish an accurate representation of the real classroom setting in this thesis.

4.6.3 Reliability and Dependability

Another important criterion for evaluating research is reliability. According to Bailey (2007), reliability refers to the consistency of findings over time. Reliable questions are those that, regardless of when they are asked, elicit the same response from interviewees. Reliable respondents are those who provide consistent answers. Conclusions are reliable if different researchers draw similar conclusions from the same data. In other words, the objective is to be sure that if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusion (Yin, 2009) . The goal of reliability is to minimize the possibility of error and bias in a study. This chapter has attempted to clarify and expose the procedures of both the data collection and analysis as clearly as possible. It is the researcher's assumption that it was as clear enough for any later interested researcher to repeat accurately and collect similar data from similar case(s).

4.6.4 Generalizability

According to Bailey (2007), generalizability involves being able to apply the results to the population from which the sample was drawn. According to Punch (1998), a common criticism of the case-study design is its inherent lack of generalizability. Since case study involves only one or a small number of data sources, this method does not easily lead to generalizable conclusions. In considering this issue, Punch (1998) suggested the purpose of the study must also be considered. In an earlier section, the researcher outlined the purpose of this study. It was clear that this case study was not necessarily undertaken to generate generalized statements, but to understand how a local language was used to assist English in the process of teaching mathematics in a particular place. The purpose of this case report is not to represent the world, but to represent the case.

As indicated earlier with regard to purposes of each type of case-study, the intrinsic case-study drew the researcher towards understandings of what was important about the case within its own world, which is not the same as the world of all researchers and theorists. Intrinsic designs aimed to develop what was perceived to be the case's own issues, contexts and interpretations (Stake, 2005). In this case study, the aims were not only to identify the different roles of Wahgi language, but also to go beyond to understand the aspects, issues and perspectives within their own contexts that might be responsible for how the local vernacular was used in a mathematics lesson. The contexts described earlier were multilingualism, the bridging program, teaching and in mathematics lessons.

However, this is not necessarily to say that intrinsic case-studies completely avoid the possibility of generalization. This study used the multiple case-study techniques because the eight cases were found in four schools, and in fact represented a total population of rural bottom-up primary schools within the South Wahgi region. The common evidence across these cases in the use of languages could encourage some generalized statements about the happenings of the cases at times still to come, and in other situations. Thus the methods for the case-work actually used in this study enabled the researcher both to learn enough about the case to encapsulate complex meanings and write these in a finite report, and also to shape a sufficiently descriptive narrative so that the readers can experience these happenings vicariously and draw their own conclusions (Stake, 2005).

4.7 Ethics

Any research study needs to abide by the ethical standards that apply to its intellectual era. This study was submitted to the Australian Catholic University Ethics Committee and permission was given for its undertaking (see Appendix A)

4.8 Summary

This chapter described the methods used to collect and the analysis of the data for this study. The methods described above were used to obtain evidence that could explain how and why local language(s) were used or not used, to teach mathematics in a multilingual classroom. A case-study approach was adopted. In the next two chapter the results and their analyses are presented.

CHAPTER 5 RESULTS -THE ROLE OF LOCAL LANGUAGE IN MATHEMATICS TEACHING

5.1 Introduction

This is one of two chapters (5 & 6) that present the results of this study. Chapter 6 presents a sample of unique results in terms of purposeful code-switching and language-use in both mathematics discourse and non-mathematics discourse within the teaching process. A particular focus is placed on Teacher K, who was found to be using her multiple languages more purposefully in her teaching than the other seven teachers who participated in this study. This chapter describes how languages were used within mathematics discourse by all teachers who participated in this study to teach mathematics in multilingual classrooms. The data here goes some way to answer the four research questions listed in both section 1.5.3 (Chapter 1) and section 4.1 (Chapter 4). These questions coalesced around the aim of the study: to distinguish the purpose of code-switching and consequently determine the role of local language used as an alternative language in teachers' verbal communication as part of their teaching process. The results presented in this chapter will show that their purpose in using code-switching was to guide their unbalanced multilingual students to learn mathematical English and mathematical content effectively. Hence the role of local language was to promote students' understanding of the verbal communication. Not surprisingly, teachers believed that by understanding the verbal communication, the students would successfully learn both mathematical English and the related mathematical content.

This chapter begins with quantitative evidence exploring the language context and practices as background information found within each mathematics lesson observed through this study. This will quantify the number of languages involved in a lesson, how much of each language was used in a lesson, and the language-paired combinations used through the language practice of code-switching.

5.2 Background Results-Language Context and Practices within Mathematics Classroom

This section aims to describe the language-context and -practice found within the multilingual mathematics classrooms that were part of this study. To begin, the recent language policy in Papua New Guinea recommended that all classrooms should promote bilingual education (*Lower-Primary Mathematics Syllabus*, 2000). This policy assumed that two languages will be used in a classroom situation. As indicated in Chapter 3, rural bottom-up primary school should use one of the 800+ fluently spoken local languages and English. This study selected a sample of bottom-up primary school from a rural setting where *Wahgi* was spoken as the local vernacular. If the teachers were strictly implementing what the new policy recommended, teachers in this linguistic boundary should be using only *Wahgi* and English in their grade 3 classrooms. Appendix C: 5.1 shows the languages that were used in the mathematics lessons observed. Clearly in most mathematics lessons in this study, teachers used three languages; *Wahgi*, *Pidgin* and English for their teaching. They did not only use *Wahgi,* but also used *Pidgin*, another language known by their students, to introduce English. This meant that the classrooms in which this study was conducted were commonly multilingual, not bilingual as the new language policy assumed.

Furthermore, the new language-policy suggested the percentage use of each language in a single lesson. According to the *Primary Mathematics Syllabus* (2000) a bridging class (grade 3) teacher should use a total of 60% of a local vernacular and 40% of English in a rural bottom-up primary school. As indicated earlier, this study did not observe one local language being used but two; *Wahgi*, the local vernacular language, and *Pidgin*, the local national language. Since the policy assumed the use of only two languages, it did not specify a breakup for three languages. However, if we consider *Wahgi* and *Pidgin* as local languages, the teachers were in line with the new policy's suggestions. The total average use of both *Wahgi* and *Pidgin* over the 16 lessons observed was 68.5% and the use of English was 22.8% (see Appendix C: 5.2). Since the schools were rural bottom-up primary school, one would have hoped that teachers would use more *Wahgi* than *Pidgin*. However, the evidence from this study showed an opposite result. It was found that *Pidgin* was used more frequently than *Wahgi*: 52% of *Pidgin* was used within the 16 lessons and only 18% of *Wahgi* was used per lesson (See Appendix C: 5.2).

When multilingual people talk together it is not unusual for them to switch between mutually known languages. Hence, in these classrooms it was no surprise to find that the speakers used the language-practice of code-switching which enabled different language combinations for effective communication. It is within such a language context that this study aimed to discover whether there was a specific purpose for code-switching and consequently identify the role of local language chosen as alternate language in this practice when teaching mathematics. The six possible language combination found in three categories identified through this study are presented on Appendix C: 5.3. In a single lesson, the language with the highest percentage is what the researcher refers to as the *leading language*, the language with the second highest as the *first supportive language* and the third highest as the *second supportive language*.

Above it was noted that *Pidgin* was the most frequently used language in these classrooms over the 16 lessons, and according to results presented in Appendix C: 5.3, it is the leading language in most lessons. Out of the 16 lessons observed, 10 of them used *Pidgin* as the leading language. Within six of these lessons, teachers used the combination *Pidgin*/English/Wahgi, where English was the first and *Wahgi* was the second supportive language. In addition, in four lessons teachers used *Wahgi* as the first and English as the second supportive language. For the other six lessons, three of the lessons used *Wahgi* as the leading language; with two lessons using the combinations *Wahgi/Pidgin*/English, and the other lesson using *Wahgi*/English/*Pidgin*. In the other three lessons, teachers used English as the leading language, and all the lessons used the combination English/*Pidgin/Wahgi*. It is within these language combinations that the purposes of code-switching were examined to identify the role of the local languages in teaching mathematics.

As indicated in Chapter 4, part of the analysis for this study was counting the number of language switches the teachers carried out in their talk, per lesson. The logic is that if a language is switched, obviously teachers move from that language to another language. Such a relationship is what the researcher refers to as ‘language pairing’. A count of the switches from one language to one of the two languages was compared to work out the possible pairing of languages within the language-practice of code-switching. To explain further: as indicated in earlier sections, the leading language commonly used was *Pidgin*. The result presented on Appendix C: 5.4 shows two possible pairings observed through this study. One of the common pairings observed was between *Pidgin* and English. In most lessons, the number of times teachers switched to using *Pidgin* was almost the same as they switched to using English, despite the difference in percentage of use of each language (See Appendix C: 5.4). The other weaker combination was the sum of switches between English and *Wahgi,* equaling the total switches into using *Pidgin*. Despite this difference in language-pairing, the purposes of code-switching were determined within all of these combinations and pairings, which will be described in sections 5.2 and 5.3.

The language-pairing discussed earlier was compared across the 16 lessons, irrespective of teachers. It is also useful to understand how each teacher used this technique. This will help understand whether individual teachers were using a particular language-combination out of habit, or whether they used different combinations as a response to the language-need of each mathematics lesson. In this study, there were not enough lessons observed per teacher to draw a conclusive result, but these data discussed here could stimulate future studies. To explore this matter the researcher considers just three teachers; Teacher K, Teacher W and Teacher M. From each teacher, data from three lessons are shown in Appendix C: 5.3. It appears that none of these teachers used a particular language-combination for pairing purposes, but instead they used varied language-combinations depending on the lessons. The researcher does not describe in detail the language-combinations used by each teacher, but to illustrate he describes the variation in the languages used by Teacher K and the language combinations she used in her three lessons. In Chapter 6, the researcher returns to Teacher K and examines in detail her language use in different parts of each lesson. In Teacher K's first lesson, she used *Pidgin* (54%) as the leading language, English (31%) as the first supportive language, and *Wahgi* (3%) as the second supportive language (see Appendix C: 5.2). In her second lesson, her use of *Pidgin* (75%) and *Wahgi* (13%) has increased, but her use of English (3%) has decreased. In other words, both lessons used *Pidgin* as leading language but the amount used in each lesson varied. But, in Teacher K's third lesson she used English (61%) as the leading language, unlike the other two lessons. She used *Pidgin* (32%) as the first supportive language, but did not use *Wahgi* at any time. Similar variations are found in three lessons observed from Teacher W and Teacher M (see Appendix C: 5.3). Such variation suggested that language combinations used, and how much each of the languages was used in the combinations, were not a habit of the teachers, who varied their language-combinations according to the needs of each lesson. Such conscious decision by teachers to shift language in response to the need of the lesson is the major focus of this study. In the following sections, when the purpose of switching is discussed, such conscious responses by teachers according to the need of the classroom will become clearer.

So far, the researcher has discussed the frequency of language-use by teachers. This included how many languages were used in a single lesson, how often each language was used, and the possible language-combinations used through the language practice of code-switching. In the following section, the researcher presents results related to the quality of each language- use, particularly within mathematics discourse (see Chapter 2 for difference between other forms of discourse). To be specific, the discussion will now focus on the purposes of code-switching that occurred within mathematical discourse, and through this evidence, the roles of local languages are identified.

5.3 Purpose of Code-Switching and Alternating Local Languages

This section aims to distinguish the purpose of code-switching found in the teachers' talk within teaching practices. The discussion in this section will be restricted to determining the purpose of code-switching and alternating local language, but alternating English will be discussed in section 5.4. Such a pattern of ordering discussion does not mean that using each language occurs in separate process. The languages are switched back and forth in almost the same process. But for logical flow of discussion in this chapter they are discussed in separate sections. The aim of discussion in this section is to determine the role(s) of the local languages. Therefore, to determine the role of local languages, this study first distinguished the purpose of code-switching. To effectively distinguish the purpose of code-switching, the ways sentences were constructed and ways the teachers spoke in teaching will be examined. The discussion focuses on two types of switching described by Setati and Adler (2001) and Skiba (1997); intra-sentential switching – switching within a sentence [code/phrase borrowing and code-mixing (section 5.3.1)], and inter-sentential switching - switching between sentences (section 5.3.2).

5.3.1 Purpose of Intra Sentential Switching

As indicated earlier, two types of code-switching were observed in this study that involved the local language as the supportive language. The results related to intra-sentential switching will be discussed in this section and inter-sentential switching will be discussed in section 5.3.2.This study had observed two types of intra-sentential switching. Setati and Adler (2001) referred to them as code-borrowing and code-mixing, which were described in section 2.2.5. To revise; code-borrowing referred to a switch that involved borrowing a term or a phrase from a different language, and then using it in a sentence constructed in another language. Similarly, code-mixing was referred to a sentence completed by two languages; one may have started the sentence in one language and then used another language to complete the sentence. The popular type of code-switching observed from most grade 3 teachers was code-borrowing, and this is not only in comparison with code-mixing, but also with inter-sentential switching. In this section, the purpose of intra-sentential switching will be determined.

Firstly, the researcher reflects on code-borrowing instances that were observed in this study. First the researcher discusses borrowing a single term from one language, and using this term in a sentence constructed in another language. The reflection on borrowing a phrase will be discussed in the later part of this section. Most terms borrowed were mainly from a mathematical register, and they were terms commonly expressed in mathematical English. Since this section is dedicated to switching and using the local languages, how these terms were used will be described in section 5.4, even though they occurred in the same sentence. However, this section will examine the purpose that the local language served when being used to construct the rest of sentence in which such terms were used. To distinguish the purpose of such language practices and the role each language played, the grammatical structure of each sentence was examined to find out how each language was used and for what purpose. As Skiba (1997) noted, one of the skills a bilingual or multilingual learns is to use such borrowed terms/phrase within the grammatical rules of the sentence. As described in section 4.5.3, the two main parts of a sentence are a noun phrase and a verb phrase (Skiba, 1997). In this study all the formal mathematical terms borrowed were commonly used as nouns, and will be described in detail in section 5.4 because they were expressed mainly in English. This meant that the verb phrases were commonly formed in the two local languages.

To illustrate this result, the researcher presents a sample of talk from Teacher W, as Talk 5.1, and demonstrates how sentences were constructed in the local languages.

Talk 5.1. Teacher W's Lesson 2, Paragraph 17 using Pidgin.

Pidgin & English			English Translation		
17.	Tr	Okay, what is a fraction? … **Fraction,** em wanem samting? …Meaning bilong em olsem … a small part of a thing. A small part of a …	17.	Tr	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.	Chn	Thing	18.	Chn	Things

This sample comes from the second of the three lessons that were observed from Teacher W. His overall language combination across the three lessons showed that he responded to the language-need of each lesson and did not stick to a particular language-combination. However, his language-combination in lesson 2 used *Pidgin* 78% of the time, so this was the leading language in the lesson, with English (16%) as first supportive language, and *Wahgi* (2%) as second supportive language.

The two languages used in paragraph 17 of Talk 5.1 by Teacher W are *Pidgin* and English. The focus of the paragraph was related to defining the term 'fraction'. The first sentence was a question in English, asking for the meaning of the term 'fraction'. As indicated earlier, English (16%) was not used often in this lesson compared to *Pidgin* (75%), but Teacher W felt the need to ask the question in English at the beginning of this paragraph. It will be shown later that most of the teachers in this study had the desire to model English use. They particularly wanted students to listen to questions in English that could be asked in tests. The second sentence of Talk 5.1 is in *Pidgin* and repeats the same question asked in English. This is a switch between two sentences and the purpose of such switching will be discussed later in section 5.3.2. For the target of this section, we consider code-borrowing occurring in the second sentence with the word 'fraction', and code-mixing occurring in the third sentence where it involves the 'definition of fraction'. The purpose of the second sentence, constructed in *Pidgin,* was that it enabled grammatically the borrowing of an English mathematical term. 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 expression in the sentence shows that the term ‘fraction’ was used as a noun-phrase and the rest of the sentence in *Pidgin* formed the verb-phrase. This meant that the local language, in this case *Pidgin*, was used as a verb-phrase, promoting the noun. The verb-phrase in the local language formed a question seeking students’ reflection on the definition of the borrowed term; fraction. It will be indicated in sub-section 5.3.2.1 that such questioning was an instance of eliciting. The teacher is asking for the definition of fraction that he already knows, but was asking in order to check if his students shared the same knowledge. To help students recall and reflect on their understanding related to the definition of the term ‘fraction’, the teacher purposefully code-switched, alternating the local language, and asked the question again with emphasis on the borrowed term, ‘fraction’. This implies that the purpose of this type of code-switching to ask question in the local language was to guide unbalanced grade 3 students to reflect effectively on their prior knowledge related to fraction. By asking the question in the local language about a term expressed in English, students could understand what they were asked for and accurately reflect and give response to the question. Therefore, the purpose of such practice of code-switching was to guide students in their cognitive process, in this case reflection to prior understanding. The role of the local language in this case was to help students understand questions asked in order to undergo an appropriate cognition process.

The third sentence in Talk 5.1 involved code-mixing. The researcher considers such switching here, but borrowing a phrase will be dealt with in the following section. As indicated earlier, code-mixing is where a single sentence is completed by using 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 is, 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 in a thing’. Reflecting on the way *Pidgin*, as a local language was used here, it is used as a pointer, directing students to be aware of the coming of an important thing: in this case, not only the formal definition, but this definition expressed in English. This shows that the students’ fluently spoken local language is used to help students grasp the formal mathematical concepts expressed in English. This verbal direction could also be a mental guidance, alerting and emphasizing what is to be learnt, but also what language is to be learnt. The purpose of code-switching was to guide students towards what was considered important for them to learn, in this case, formal definition of fraction expressed in English. To help students become mentally alert, teachers used the language students spoke fluently. The local language was again used as a resource and given the supportive role in this switching process. Therefore, the role of the local language was to alert students to what was considered important by the teacher to be learnt. In general, the local language was used to help students understand what was required, what was important and what was to be learnt.

Thirdly, this section describes how teachers borrowed a phrase composed in another language and then used it within a sentence constructed in the original language. As indicated earlier, in this study, most phrases comprised mathematical English words and were used in sentences constructed mainly in the local languages (see Appendix C: 5.4). The local languages served to construct the sentence in which the phrases were accurately used, within the grammatical rules. The ways phrases were used in sentences followed the same patterns as borrowed single terms. In the following illustration in Talk 5.2, a phrase expressed in mathematical English is used within a sentence constructed in a local language by Teacher B.

Talk 5.2: Paragraph 13 of Lesson 1 from Teacher B

In Wahgi		**English Translation**	
13 (b) Tr.	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.	13. (b). Tr	We will now look at 'units of measuring weight'. We will look at the smallest unit to the biggest units.

Talk 5.2 presents paragraph 13(b) from the single observed lesson of Teacher B. This teacher's language combination was unique; he used *Wahgi* (46%) and English (43%) almost equally in his talk with *Pidgin* (5%) playing a very minor role. His language pairing was done evenly between *Wahgi* and English (see Appendix C: 5.4).

In Talk 5.2 the sentence is constructed in *Wahgi*, and a mathematical English term and a phrase are borrowed within the sentence. The lesson in which Talk 5.2 was a part was about units of measurement. The phrase borrowed here was ‘units of measuring weight’ and the word borrowed was ‘unit’, both in mathematical English. Both are embedded within the local vernacular language, *Wahgi*. The way this is expressed in *Wahgi* was, ‘we will look at *units of measuring weight*, from smallest to the biggest *units*’. The researcher has already described the purpose of local language in terms of word-borrowing in mathematical English. The researcher will only reflect on phrase-borrowing in this section, but it will be clear that both processes are similar in the way the local languages are used. From the translation of Talk 5.2, it is shown that the borrowed phrase in mathematical English acted as a noun in the sentences. The rest of the terms used to form the verb-phrase were mainly in *Wahgi*. From the first sentence, *Wahgi* is used to say that they were going to do the looking at or studying. As the teacher continued and said that the looking at or studying was going to involve the ‘units of measurement’, this indicated that the teacher used the students’ fluently spoken language to inform the students of what they will be doing to the unit of measuring weight, which is obviously forming the verb phrase. Similarly, in the second sentence, the teacher makes it more specific in what they will be looking at or studying in that 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 fluently spoken language is used to inform students what they will be studying. The purpose of code-switching in this case was again to alert the students to what important knowledge will be taught. Therefore, the role of local language was to help students understand what was important, and that more important ideas were about to come in the lesson that would connect with the present discussion.

So far, the researcher has discussed the way the local languages were used through code-borrowing and code-mixing. One of the local languages was used to construct the sentence. The mathematical terms/phrase, expressed in English, were borrowed and used within the grammatical rule of the sentence. Similarly, the researcher has discussed the purpose of using the local language to form part of sentence. Towards the end of each teaching episode, a brief discussion related to the purpose of each switching and the role of local language was highlighted.

However, words, phrases or parts of sentences do not stand alone when expressing meaning, but are strung together in sentences or paragraphs, either in spoken or written form. These bigger chunks define different types of discourse. This study mainly focused on mathematical discourse found within the larger classroom discourse. The following sections describe the purpose of switching between sentences/paragraphs and using the local language within mathematical discourse. The researcher uses Skiba's (1997) description of the switch as 'inter sentential switching'.

5.3.2 The Practices of Inter Sentential Switching.

In section 5.3.1, the researcher reported how teachers in this study used code-borrowing and code-mixing using the two local languages (*Wahgi* and *Pidgin*) to enhance effective teaching in mathematics lessons. These terms/phrases were certainly part of a complete sentence, and each sentence was part of the teacher's communication in the classroom. Skiba (1997) described code-switching that was taking place at the end of a complete sentence or group of sentences (paragraph), in most with code-borrowing in sentences constructed through 'inter-sentential switching'. To determine the purpose of inter-sentential switching and the role of local language, this study began to examine what the teacher sought to achieve through talk conducted after switching language and alternating the local language for teaching. The ways of talking in teaching processes that this study targeted were those described by Mercer (1995) as having the potential to guide knowledge construction.

Reflecting on the language context, most students were meeting English, which expressed most of the mathematics concepts in the lesson, for the first time. The teachers were dealing with students who were unbalanced multilinguals. According to Cummins (1985), these students were faced with negative impacts in their cognition process due to their unbalanced language background. According to the new language policy the local languages, *Wahgi* and *Pidgin*, were to be used as resource to enhance teaching so that unbalanced multilingual students, in this case, could be effectively guided to learn mathematical English and mathematical content. Therefore, the assumed purpose of code-switching within the teaching process that this study targeted was to guide effective learning of unbalanced multilingual students. The way forward to achieve such a purpose was by taking advantage of the role of local language in the teaching process. To confirm the purpose of code-switching and identify the role of local language, this section will describe and examine the ways of talking conducted in the local language after code-switching, described as inter-sentential switching. The ways of talking identified through this study that had potential to guide knowledge-construction of unbalanced multilingual students were questioning, explaining and repeating. In addition, within the techniques of repetition, teachers repeated explanations and questions using the local languages. The following section presents the description of these ways of talking, highlight the possible purpose of such language practice and identify the role of local language in the whole process.

5.3.2.1 Asking Questions

The first type of talking identified through code-switching was to ask questions. In most cases, it seems that teachers who participated in this study commonly asked questions at the end of an explanation or instructions. Mercer (1995) described the asking of questions that teachers already knew the answer as a form of eliciting. This was common practice for teachers observed in this study. What concerned this study was whether the questions were asked in the local languages. To illustrate, Talk 5.3 presents Teacher M's talk, which involved questioning in one language about something said in another language.

Talk 5.3. Questioning by Teacher M in Lesson 2, Paragraph 74.

In Pidgin & English		**English Translation**	
74. Tr	Number 2 mi tok … write the missing numbers. Write the missing numbers…. Em mi putim square, square, square namel …So the front number is given namel (middle) number is missing, the answer is written. ….. So bai yu mekim wanem long painim missig number, namel bai yumi mekim wanem?	74. Tr	I am talking about number 2 … Write the missing numbers. Write the missing numbers…. That's where I put square in the middle. So the front number is given, middle number is missing, the answer is written. … So what are you going to do to find the missing number in the middle?
73. Chn	Divide	75. Chn	Divide

This study observed three lessons from Teacher M. He changed the language-combination as demanded by each lesson and did not stick to one language-combination. In two of Teacher M's lessons (L1 & L3), he used *Wahgi* as the leading language, and in the other (L2) he used *Pidgin* as the leading language (see Appendix C: 5.3).

The Talk in paragraph 74 is from lesson 2. As indicated, overall in this lesson the leading language was *Pidgin* (65%), the first supportive language was *Wahgi* (16%), and English (11%) was the second supportive language. Interestingly in this excerpt (Talk 5.3), the language-pairing this teacher used was evenly shared between *Pidgin* and English. He switched from English to *Pidgin* to ask the question that assessed students' understanding. He starts with *Pidgin* in the first sentence to refer to the exercise number. He then switches to English, to read the instruction, asking the students to fill in the missing numbers. He switches again to *Pidgin* to explain that he put the little square boxes in which they will fill in with the missing number. He switches again to English to explain that the first number is given, the middle (by mistake he uses the Pidgin word '*namel*' which means middle) number is missing and the answer is written. From here he switches *to Pidgin* to ask the question, to check if the students know what to do. In *Pidgin* he asks, 'so what are you going to do to find the missing number'.

This illustration showed two types of talking that were conducted in the local language after switching; they were explaining instructions given in English, and asking questions to check whether the students understood the previous instruction explained in *Pidgin*. Since this section is concerned with questioning, it reflects on the purpose of code-switching to ask questions and determine the role of local language in this conversation. As indicated earlier, the way the question was asked here can be termed eliciting. It involved requesting students to reflect on and illustrate what they understood from the explanation given about the instructions written on the board. The purpose of code-switching to ask question in the local language was to guide students to reflect effectively on their understanding of the instructions recently written in English and explained briefly in Pidgin. It is also clear that the role of local language was to help students understand what they were asked for as part of eliciting, helping them to accurately reflect and respond correctly.

5.3.2.2 Explaining

The second purpose of switching and using the local languages was to explain the major mathematics concept to be taught in that lesson. To illustrate, Talk 5.4 is from a lesson in which a formal definition of angle is expressed in English and the teacher switches to *Pidgin* to explain the meaning.

Talk 5.4. Explanation by Teacher W in Paragraph 65 of Lesson 3

Pidgin & English		**English Translation**
65.	Tr	Shape yes. Inside long shape, ah where igat corner long en. Klia ah? Inside long shape igat corner, orait. Okay, description bilong angle em olsem …. Angles are formed, formed where two lines cut through each other, okay. …. Tupela line save cutim through na brukim long en, Yumi gat wanpela line kam olsem, narepela line ikam olsem ah. Tupela icutim long dispela … two lines cut through each other……. narepela line ikam down long hia na dispela line ya igo antap olsem. So, tupela line i cutim now. Tupela line i formim angle, narepela angle em, long hia, igat kona long hia. Narepela corner long we? Narepela corner long we, dispela line ah?	65. Tr Shape yes. Inside a shape, where there is a corner. Is that clear? Inside a shape where there is a corner, all right. Okay, the description of angles is like this … angles are formed where two lines cut through each other, okay. … Where two lines cut through. We got one line coming this way, another line coming this way. Two of them cutting in here… two lines cutting through each other … another line comes down here and this line goes up like this. So two lines are cutting each other now. The two lines are forming angle, another angle is here where there is a corner. Where is the other corner? Where is the other corner from this line?

Teacher W was one of the teachers who changed language combinations, as demanded by the lesson situation. He did not persist in using just one combination throughout all his lessons. In two lessons (L1 & L2) he used *Pidgin* as the leading language, and in the other (L3) he used English as the leading language. In his language combination for lesson 3, the teacher used *Pidgin* (69%) as the leading language, English (20%) as the first supportive language, and *Wahgi* (6%) as the second supportive language. Obviously, the language pairing was commonly between *Pidgin* and English (see Appendix C: 5.4).

In paragraph 65 of Talk 5.4, the discussion was about the definition of angles. The teacher started this paragraph in *Pidgin*. He explains in the first two sentences that angles are inside a shape or where there is a corner (edges). Then he switches to English and expressed the formal definition. He says in English, 'angles are formed where two lines cut through each other'. Then he switched back to *Pidgin* and repeated the formal definition of angle. Continuing in *Pidgin* he began a more detail explanation as he drew the lines on the board. He said, 'we have one line coming this way', as he drew, then he said, 'another line comes this way', as he drew, and then he said, 'the line cuts here' as he pointed to the angle. Then he switched back to English and he said, 'two lines cut through each other', repeating what he has just said in *Pidgin*, which was part of the formal definition of an angle. He repeated again what he said earlier as he traced over the line he drew and identified the corners produced as the two lines met, interestingly using mainly *Pidgin* for this, but code-switching occasionally to English. Through this talk, it was important to see that *Pidgin* was used to talk around the main concept expressed in English. In this case, he expressed the formal definition of angle, 'where the two lines cut each other', and he used *Pidgin* to demonstrate this by drawing lines as he talked in *Pidgin* and correctly located the angle where the lines cut each other. Such a way of talking helped students understand the formal definition of angle. But at the same time they gain access to the formal English expression of the definition. In most cases, such as this, the formal English expression was what the teacher wrote on the board, and this was what the students copied in their books. So although the explanation was in *Pidgin*, what is written by both the teacher and student was the formal definition of angle in English. The purpose of code-switching and using a local language was to effectively guide students to understand the formal mathematical concept, in this case the notion of angles and how to locate them on a geometrical shape created by lines. To achieve this purpose, the local language was used to explain the definition. This illustration showed that the role of local language was to help student understand the concepts and practices related to angle.

5.3.2.3 Repeating

Teachers often switch languages to repeat what was said earlier in a different language. In most cases, the language of the earlier completed sentence was always in English and in most cases they were either a question or explanation. One of the oral practices that enhanced students' cognitive processes that Setati and Adler (2001) emphasized was 'talking to learn', and, in their view, using the students' language was important for this. For a multilingual, talking to learn would involve first switching, second using the fluently spoken languages and third repeat what was said in the language of teaching in their own local language to make sense of it. This was assumed for a long time to be only a mental process that students engaged in. But as Setati and Adler found, and as was also found in this study, teachers were purposefully using this language-strategy to guide students when in the Zone of Proximal Development, to enhance their students' learning. The teachers used 'repeating' in a number of ways within their talk. These included repeating explanations and repeating questions in the two local languages.

First, teachers switched and used the local languages to repeat explanations. As indicated earlier, most of the talk analyzed for this study was from mathematical discourse. This part of the talk involved teaching the new and important concept of the lesson. In such teaching the teachers tried to provide scaffolding for the students learning within their ZPD. In a multilingual classroom, the way forward was code-switching used in such a way that the students' language scaffolds the students' learning. This study found that to achieve this, teachers had commonly to switch and use a local language to repeat what was explained earlier in a different language. To illustrate, Talk 5.5 shows a teacher repeating an explanation.

Talk 5.5. Paragraph 33 of lesson 1 from Teacher J

In Pidgin & Wahgi	**English Translation**
32. Tr …. Okay nau, 'two times' lo bilong mi em Anis tok, mi askim na em tok pinis olsem, olgeta number tambelo yu mas timsim igo long olgeta namba antap. … *Number ya menero panda number eh pel ep minero pel timsim era nimin*… Yupela klia?	32. Tr …. Okay, my rule for doing 2 times was mentioned by Anis already that all numbers below, you will times with all numbers on top. … The number that is found below, we are saying that you will multiply them with all the numbers on top.

In Talk 5.5, the talk by Teacher J came from his first lesson within paragraph 32 of the transcript. Two of Teacher J's lessons were observed. In both lessons his language combinations were consistent. He used *Pidgin* as a leading language, *Wahgi* as the first supportive language, and then English as the second supportive language. This language combination was the common one used in most of the 16 lessons observed in this study (see Appendix C: 5.3). In this lesson (L1), Teacher J used *Pidgin* (69%) as the leading language, *Wahgi* (24%) as the first supportive language, and English (1%) as the second supportive language.

From Talk 5.5, Teacher J first used *Pidgin* to explain the rule of multiplication by numbers in tens and hundreds, and then switched to *Wahgi* to repeat the same explanation. Teacher J explained that the rule was to multiply all the numbers below with all the numbers on top in *Pidgin*. The rule that was explained was paraphrased and repeated in *Wahgi* again. In doing this, the teacher indicates that the rule was important and he used the language resources he and the students shared through the language-practice of code-switching to explain the same rule. It may be argued that *Pidgin* is a language students should have already spoken fluently, but, the teacher is trying to make sure that the students get to hear the important concepts in all the languages they speak fluently by using this repeating strategy. The purpose of code-switching in this situation was to guide students to use correct procedural steps effectively to multiply numbers in tens and thousands. In order to do this correctly, the students needed to understand what is in fact involved and teachers ensured this by using the language students spoke most fluently. Therefore, the role of both local languages used in this case was to help students understand how to use specific procedural steps, in this case those that were involved in multiplying numbers in tens and hundreds.

Secondly, an analysis of the data also showed that teachers switched and used the local languages to repeat questions. Such a way of talking relates to what Mercer (1995) described as eliciting. This in most cases involved asking questions for answers that teachers knew already. According to Mercer (1995) the purpose of such talk is to enable the teacher to be aware of what the students already know, and also make students feel that they own the ideas. Mercer (1995) was referring to a classroom environment where one language was involved. But a similar use of this strategy was found in these multilingual classrooms. Repeating the question, in this case in a different language, would ease the linguistic challenge and result in more effective communication. A sample of such talk is presented as Talk 5.6.

Talk 5.6. Repeating a Question by Teacher K in Lesson 1, paragraph 57

	In Pidgin & Wahgi		**English Translation**
57. Tr	na taim yu kam long dispela 30, em hamaspela 10?... 10 nalnak paim?	57. Tr	and when you come to this 30, how many 10s are there? … How many 10s are there?

Talk 5.6 is from Teacher K's first lesson, found in paragraph 57. She was using *Pidgin* to ask the question and switched to *Wahgi* to repeat the question. In this lesson the amount of *Pidgin* (54%) and English (31%) used by Teacher K were dominant, with *Wahgi* (3%) used significantly less.

Although *Wahgi* may have been used less often in the lesson, in this paragraph Teacher K repeats the question in *Wahgi* in order to help students understand what they were asked. From Talk 5.6, Teacher K makes a statement in *Pidgin* and asks a question towards the end. She switches to *Wahgi* and does not repeat the whole statement but repeats only the question in *Wahgi*. In the statement, when she comes to 30, the teacher asked the question, "How many tens are there?" After asking the question she switches from *Pidgin* to *Wahgi* and repeats the same question. The purpose of code-switching and using the local language was to guide students to reflect effectively on their prior knowledge and so, she hoped, give an accurate response. As indicated earlier, asking a question as such cases was an instance of eliciting and required students to reflect on what they already knew or understood from the current teaching. To enable students to understand what they were asked for and accurately retrieve prior knowledge, teachers needed to repeat the question in the language the students fluently spoke. Therefore, the role of the local language in this case was to understand, and in this case understand what the questions were asking for. The teacher shows through such switching that she wanted the students to understand what they were asked for by repeating the question in the language they spoke fluently, in this case *Wahgi*.

The emphasis in this section has been to discuss the purpose of code-switching and the role of the two local languages; *Wahgi* and *Pidgin*. Generally, the purpose observed through the ways teachers talked showed that the language-practice was used to enhance the teaching process so that unbalanced multilingual grade 3 students could effectively be guided to learn mathematical English and mathematical content. Within this process, the role of a local language was to help students to understand in order to learn mathematical English and mathematical content effectively. The local languages were not used alone, but they were switched on and off around English. The following section discusses the purposes of switching and using English.

5.4 Purpose of Code-Switching and Alternating English

This section aims to present results related to the purpose of switching and using English. As indicated in earlier sections, the target of this study was to distinguish the purpose of switching and using the local languages, where the role of a local language could be identified. Therefore, in sections 5.3 the purposes of switching and using the local languages using data from this study were discussed. However, English was one of the three languages used in the same lessons as the two local languages, and they all contributed to effective teaching. The way the teacher used these three languages was through the practice of code-switching. To understand more fully the role of the local languages, there was a need to isolate the role of English. The researcher will return to section 5.3 to use the same illustrations to discuss the purpose of switching and the role of using English through the two types of switching: intra-sentential switching (involving code-borrowing and code mixing(section 5.4.1), and inter-sentential switching (section 5.4.2).

5.4.1 Purpose of Intra-Sentential Switching

To determine the purpose of intra-sentential switching involving English, this section describes and examines the language practices of code-borrowing and code-mixing. First, to describe the purpose of switching and using English within code-borrowing, the researcher refers to discussions in sections 5.2. It was noted there that most terms/phrases borrowed were from a mathematical register, and mostly expressed in mathematical English. The list of common terms/phrases borrowed by teachers across all observed lessons is presented in Appendix C: 5.4. These terms/phrases were from various school mathematics strands such as numbers (whole numbers & fractions), the four operations (add, subtract, divide & multiply), measurement (weight, perimeter, distance), and geometry (shapes, angles). The terms borrowed were found to be in three categories. As Chapman (1993) described, the first composed of terms/phrases that had only one mathematical meaning (e.g. fraction, multiplication, etc), second were terms that had two meanings, but one of them is dedicated to mathematics (e.g, takeaway, times, corner, etc), and the third was a group of words (phrase) from ordinary English but used to express technical mathematical meanings (e.g, place value, carry over, put down).

To examine the purpose of switching and using terms/phrase expressed in mathematical English, the researcher refers back to the illustrations used in section 5.3. Using an illustration from Talk 5.1, the term ‘fraction’ was borrowed and used within the sentence constructed in *Pidgin*. Similarly, from illustration Talk 5.2, the phrase ‘unit of measurement’ was used within the sentence constructed in *Wahgi*. In order to distinguish the purpose of switching and using each of the three languages, the sentence constructed by these languages were examine grammatically. In section 5.3.1, it was indicated that the local language was purposefully used as a verb phrase. Therefore, the borrowed mathematical terms expressed in English were purposefully used as a noun phrase. The noun in a sentence is regarded as the head-word and the verb-phrase describes the action performed by the noun. This means that the noun plays a central role in the overall sentence-structure. Therefore, for the teachers to promote the mathematics terms expressed in English, they borrowed the English mathematics terms and used them as nouns within the sentences constructed in the local language.

Secondly, to describe the purpose of switching and using English within code-mixing, where one part of the sentence is in the local language and the other part was obviously in English, the researcher again refers to section 5.3.1. In Talk 5.1, for the third sentence the teacher used *Pidgin* in the first part of the sentence and switched to English to complete the second part of the sentence. The first part of the sentence in *Pidgin* sought to introduce the meaning of the term ‘fraction’. The teacher switched from *Pidgin* to English and expressed the formal definition of a fraction. This clearly showed that the teacher wanted the students to hear the formal definition of ‘fraction’ in English. It was obvious throughout this study that one of the key purposes of switching to and using English was to promote the formal mathematics expression such as definitions.

5.4.2 The Practices of Inter-sentential Switching

This sub-section examines the purpose of switching and using English at the end of a sentence or paragraph. In section 5.3.2, the researcher has indicated that teachers switched and used the local language in four main ways of talking to teach mathematics. The teachers switched and alternated, using the local languages to repeat, explain and ask questions. The description of these incidences showed how the local languages were used to promote a formal mathematical concept in most cases expressed as a word, phrase or an expression in English. To further demonstrate, I will use Talk 5.1 from section 5.3.1. From the first sentence, a question is asked in English. The question the teacher asked was, 'what is a fraction?' Before this question, the teacher was using *Pidgin,* and he purposely switched to English to ask this question. Why the teacher switched from *Pidgin* to English to ask this question is not obvious, although it was written on the black board in English. But, examining how *Pidgin* was used after switching back from English, it is clear that the teacher regarded both the question, and the language used for it, as important. As indicated earlier, the teacher switched into *Pidgin* and repeated the question asked earlier in English. Another illustration is found in Talk 5.4 in section 5.3.2. The theme of the discussion was about forming angles using lines. The teacher explained in *Pidgin* how angles could be formed when two lines meet, but the explanation was repeated in English. Such a behavior showed that the teacher wanted the students to understand the definition spoken in the language they spoke fluently, but the teacher also wanted the students to learn how this formal definition was said in English. Such linguistic behavior clearly indicates that the teacher targeted the need for the students to hear not only the meaning but also the formal expressions in English. This is one of the important purposes of switching that was seen in the mathematical discourse data recorded throughout this study. The purpose of switching and using English was to present the formal mathematical language. It is important to note that such ways of talking did not only promote understanding or promote formal expression in English, but also contributed to learning formal mathematical English meaningfully.

So far, the researcher has used some illustrations found in section 5.3 and 5.4, to emphasize that switching and using English was done purposefully to promote formal mathematical English. This could also be triangulated with the way the two local languages were used and the way they were trying to promote formal mathematical English through the practice of code-switching. These interpretations relate to the purpose of switching between the three languages as used by the teachers. The researcher describes this as the unconscious purpose of code-switching. In the following sections, the researcher discusses the reasons teachers gave in interviews for switching and using each of the three languages: the two local languages (*Wahgi* and *Pidgin*) and English. The researcher refers to this reasoning as their conscious or intended purposes for code-switching.

5.5 Teachers Intended Purpose of Code-Switching

In the earlier sections, the researcher discussed the purpose of switching and roles of three languages *Wahgi, Pidgin* and within mathematical discourse. These purposes and the roles of each language were determined by interpreting the ways teachers switched and used the three languages, with emphasis placed on the local languages in their teaching process. This section also discusses results related to the purpose of switching languages, but this time analyzing what teachers said was their intended purpose of code-switching and perceived role of each languages: *Wahgi, Pidgin* and English. As indicated in the methodology chapter (Chapter 4), data from interviews and questionnaires were collected from teachers for this study. The analysis of these data identified a number of common views related to the purpose of code-switching and role of the three languages. The first sub-section (5.5.1) discusses the purpose of code-switching and the role of local languages. The second discusses the factors that might have stimulated the teacher to believe that there was a need for using code-switching and using the local language (sub-section 5.5.2). The third sub-section (5.5.3) discusses the teachers' perceived importance of English, confirming the importance placed on all languages used for teaching purposes.

5.5.1 Teachers' Perceived Purposes of Code-Switching and Role of Local Languages

The main aim of this section is to explore why teachers at times switched to *Wahgi* and/or *Pidgin* within the mathematical discourse. Through the analysis of the teachers' interviews, two main reasons surfaced. The first was related to students' understanding, and the second to maintaining the local languages.

First, it was obvious through the interview that the main intended purpose for teachers switching and using the local languages as a resource was to ease the language difficulty posed by the introduction of English as a foreign language for the first time to grade 3, but often used to express most mathematical concepts. The teachers believed that to guide students to learn successfully, the students needed to understand the mathematical ideas expressed in English. But the teachers also indicated that, to help students to understand and learn, they the teachers needed to use the languages the students fluently spoke as a resource within their teaching. To illustrate, the researcher examines what Teacher M said in the interview. The researcher interviewed Teacher M while watching the video replay of his teaching. The exchange is found in Talk 5.7.

Talk 5.7: Paragraph 1 - 8 and 13 & 14 from Teacher M's Interview

P/1(b) – Researcher	Okay, you can see, you have switched from Pidgin to Wahgi at that particular time. Now, the word you were using was 'whole' and then you were asking nicely what do we say this in Wahgi language. So why did you make this change?
P/2- Teacher	This is something like this, there is sometimes some new words from English, when I use some words like 'whole' now, 'whole' is a common English words meaning 'fully or one whole thing'. So, then I use this word 'whole' to relate to fraction where we break it into half, quarters and so on. But these children do not understand what 'one whole' of something means in English. So I have to make it clear what 'one whole' means using the Wahgi language too. We have something like this in Wahgi language. So I switch from Pidgin to Wahgi language (Wahgi) so that students have got a good concept, clear concept about the meaning of this word.
P/3 - Researcher	So you think the purpose of you doing this (switching language) is to help children to …
P/4 - Teacher	fully understand so that …
P/5 - Researcher	Okay, it's for understanding that you do this. You think that if you use Wahgi, you think children will understand?
P/6 - Teacher	When I use Wahgi language, they fully understand the meaning of the word 'whole' in English.
P/7 - Researcher	So Wahgi language you use it to help students understand.
P/8 - Teacher	yes

The researcher asked why Teacher M switched and used the *Wahgi* language, as they both could see on the video. He explained in paragraph 2 that students did not understand the meaning of the concept 'one whole' in English and so he switched into *Wahgi* to help students become clearer in the meaning of the concept. He also indicated that the concepts of 'one whole' did exist in *Wahgi* culture and the *Wahgi* language was able to express such a concept. Therefore, he thought that expressing the related concept in the local language would help the students make the connection with the concept expressed in English. To confirm, the researcher started a statement about the purpose of switching and the teacher completed the statement by saying that it was to help students fully understand. In paragraph 2, 4 and 8, the teacher repeated the purpose of switching. The teacher indicated clearly that he switched language to help students understand the concept of 'one whole' through their fluently spoken language. Such a response was common in what most teachers said in interviews carried out in this study. The intended purpose of code-switching in this episode, as the teacher said, was to make concepts expressed in English clearer for the unbalanced multilingual students. Since these students were being introduced to English for the first time, they needed to use local language to help them understand mathematical concepts that were mainly expressed in English. Therefore, the role of local language was to promote understanding so that this could effectively guide their learning of mathematical English and mathematical content successfully. This tends to confirm the findings of section 5.2 and 5.3 that the purpose of code-switching was to guide unbalanced multilingual students by promoting understanding through the use of the local language to learn mathematical English and mathematical content effectively. Hence data sourced in two different ways agree that teachers switched and used the local language to help students understand as they were guided in the learning of mathematical English and mathematical content.

Second, the teachers in the interviews also indicated that one of the intended purposes of code-switching and using the local languages was that they aimed to contribute to promoting and maintaining the local languages. A lot of languages in the world are dying off because they are not used, de-emphasized and regarded as unimportant. As indicated earlier, Teacher M knew that the concept of 'one whole' was part of *Wahgi* culture, and his purpose in using *Wahgi* at this point was to help the students understand the concept and learn the English expression meaningfully. Teacher M thought that using the cultural concept in *Wahgi* language could assist this process. But in addition, such processes not only helped understanding, but contributed to promoting and maintaining their *Wahgi* language. This was also the view of Teacher K expressed in the sample of conversation presented in Talk 5.8.

Talk 5.8: Paragraphs 13- 16 of Teacher K's Interview

P/13 - Researcher	Do you see any benefits in this change of language? Do you see any benefits since you are allowed to use more than one language, which is, you can use language other than English. Is there any benefit? … Igat gutpela bilong en? (Is there any benefit in doing this). Is there any benefit that you see or there are no benefits?
P/14 - Teacher	There are, we can say, in a way that, some of our 'tok ples' (Wahgi), our vernacular language that we suppose to know and understand instantly, but we were speaking English and we never practiced this. Some words like counting ah, from 1 to 20, there were some words that our people used but we have never come across this and now that reform has come in, they are bringing up words that hidden away somewhere and maybe we were going to do away with this words but now we bring them up the words and our kids are trying to count in their own language.

As indicated earlier, Teacher K had 20 years of teaching experience and started teaching when English was compulsory. The researcher asked if she could see any benefit of using languages other than English, particularly using the local languages for teaching and learning purposes. She indicated in paragraph 14 that there were and she described what she was referring to. In her response, she used the term ‘we’ to indicate that she was included in her description. She indicated that they spoke English often and never expressed some of the mathematical concepts in the local languages. She gave examples of numbers names from 1 to 20. She indicated that they never used the *Wahgi* numbers names under the old policy, but used only English names. She goes on to say that through the reform under the new language policy, as a teacher she could now put some emphasis on this cultural knowledge and allow students to use the *Wahgi* number names along with English terms. She also indicated that if these words were not used, they would be lost, which means the whole of the local language could eventually be lost. Teacher K thinks that using the local language, particularly such mathematical terms, can help promote and maintain the local language.

In this section, I have described teachers’ intended purposes of code-switching and perceived roles of each language. Specifically to guide learning, students’ needed to understand what was expressed in English through the use of their fluently spoken local languages. But to do this, the teachers had to know what the students did not understand. It is this awareness that stimulated teachers to switch and use the local language. The following section explores some factors that might have led the teachers to believe there was a need for code-switching and using the fluently spoken local language.

5.5.2 Factors Stimulating Code-Switching

This section discusses what prompted the teachers’ ‘need to know’ what the students did not understand. As will be illustrated, this encouraged the teachers to switch and use the local languages. Through the interviews, teachers indicated four common factors that together played major roles in this process. The first factor related to the students’ delay in responding or no response when a question was asked, or a pause by the teacher that required some kind of response from the student. As Mercer (1995) indicated, elicitation was one of the ways of talking in the teaching process, where teachers asked for or paused for a response. The teachers who participated in this study clearly used eliciting. But this study was interested in what the teacher said about students not responding and whether this encouraged teachers to switch languages.

Teachers indicated that when students did not respond, they thought that the students did not understand. This encouraged them to switch and use a language that the student would easily understand. To illustrate, the researcher examines Teacher W's comments in Talk 5.9. Teacher W was shown his own teaching on the recorded video as part of the interview.

Talk 5.9: Paragraph 5 to 8 of Teacher W's Interview

P/5c- Researcher	You are changing language,…. Why do you think you did that?
P/6 - Teacher	Yes, I asked them in English students cannot, I mean students cannot respond quickly so I thought there was a need for me to change language, so that …
P/7- Researcher	so children did not respond that's why you decided to change…
P/8 - Teacher	change so that they could respond. I know that they did not understand what I was saying, in the language I was using.

As they were watching, the researcher draws Teacher W's attention to a moment when he switched the language. In paragraph 5c, the researcher asks why he switched the language. In paragraph 6, Teacher W did not immediately give the reason why he switched, but he told the researcher some of his background thinking. He begins by saying that he used English to ask the question. The teacher knew that English was a foreign language for all of the students. With this knowledge, the students did not respond quickly and, as Teacher W indicated, he knew that there was a need for him to switch language. Obviously he would have switched and use the language that the students spoke fluently. In paragraph 7, the researcher wanted to confirm if this was his reason to switch and in paragraph 8, the teacher confirmed that he switched so the students could respond. He went further and indicated that English was a foreign language and the students did not understand the question he was asking. Obviously, from the delay in students' response to the question and the teachers' knowledge that English was a foreign language, he concluded that the students did not understand, and, therefore, he thought switching language to a fluently spoken language was a good solution.

The second factor the teachers used as a basis for switching language was the body language of the students. Teachers used certain students' body language as a sign of misunderstanding.

Teachers indicated that, as they were teaching, they were always conscious of their students' body language. If they had sighted an expression that suggested misunderstanding, this prompted them to switch and use a language in which they could more easily and effectively communicate. To illustrate, the researcher examines the view expressed by Teacher W and the sample of his conversation is presented in Talk 5.10.

Talk 5.10: Paragraph 119 to 134 of Teacher W's Interview

P/119- Researcher	Now you go on from Pidgin to local language. I just want to know why? What made you think that this was the time you suppose to use local language, that situation, that particular situation?
P/120 – Teacher	That's the activity part.
p/121 - Researcher	That's right
p/122 - Teacher	Yes, I have to explain that one in 'tok ples' (Wahgi) and make it clear, they have a clear concept of what they are going to do.
P/123 - Researcher	What about the Pidgin? Did they, you used Pidgin. Pidgin was not enough?
P/124 - Teacher	Pidgin was enough but when I look at their faces, they have some facial expression that indicates that they need further explanation so I …
P/125 - Researcher	so you thought you had to use the local language?
P/126 - Teacher	yes

In this conversation, the researcher wanted to find out what made Teacher W switch between the two local languages. Initially, in paragraph 122, the teacher indicated that he just decided he would switch to *Wahgi* to help students understand what they were expected to do. The researcher continued and asked if *Pidgin* as a local language was not enough to do the same job. This question made Teacher W say that he looked at the facial expressions of the students when he was using *Pidgin*, and he still saw misunderstanding, so he felt a need to switch to *Wahgi* language. This seemed to imply that no matter what language they use, teachers are constantly studying body language to work out whether their students understood. Among a variety of strategies they can employ¸ they switch to the fluently spoken language as one means of assisting students to understand.

Third, the teachers indicated that they did not only base their decision to switch on the delay in students' responses or body language. They also used an inbuilt bilingual skill which enabled them to judge when would be the suitable time to switch languages, particularly between English and the local language. As bilinguals, teachers already possess the skills of switching at the right time and purposefully to enhance effective communication. In section 5.3, the researcher described how switching was used to repeat, ask questions and explain. During the interviews the teachers indicated that according to their personal judgment, they just knew when to switch to help students understand. They did not always have to wait for some kind of response or facial expression from the children to switch language. To illustrate this view, the researcher reflects on what Teacher W said in Talk 5.11.

Talk 5.11: Paragraph 25 and 26 of Teacher W's Interview

P/25 - Researcher	This situation in any way like, maybe the look of the children, or maybe the environment or maybe the kite itself or maybe anything, that stimulated you to change?
p/26 - Teacher	I thought that if I use English they might not understand, so that is why I used Pidgin so it will make them familiar with what I was ……….

In paragraph 25, the researcher is asking Teacher W what might have caused him to switch from English to *Pidgin*. The researcher outlined a number of possible factors that could prompt a language switch. This included body language, the environment and the object (kite). The teacher did not pick any of those as factors, but he indicated that his personal assessment made him feel he should change languages. In paragraph 26, he clearly indicates his feeling that, if he had used English, the students would not fully understand, and therefore he used *Pidgin* to help students become familiar with and understand what he was teaching. Such an expression indicated that teachers assess the content, context and situation dynamically to judge the appropriate time to switch, to help their students understand. They did not necessarily have to depend on external factors to switch languages.

Fourth, the teachers indicated that one of the factors that stimulated them to switch was to match the language with the appropriate context or situation while teaching a particular mathematical concept. In most cases, the teachers said that they switched and used the local language to present a cultural context related to the major mathematical concept taught in a lesson. Since English was a foreign language and often could not be used adequately to describe a context related to the culture of the students in such a way that helped students understand the major concept through the context, the teachers were stimulated to switch and use the language the students spoke fluently. To illustrate, the researcher examines what Teacher M said about this view and the sample of his conversation is presented in Talk 5.12. As in all of the interviews, Teacher M and researcher are watching the video replay of the lesson.

Talk 5.12: Paragraph 21-28 of Teacher M's Interview

P/21 (a) - Researcher	Again, I have asked this question before but I'll ask again. You have used Wahgi for some time now and now you are going into the context of killing pig. Now why didn't you us Pidgin instead of Wahgi? Did you think about switching it into Pidgin that time, why did you keep to using Wahgi? Is there any reason why you wanted to use Wahgi all this time when you wanted to talk about pig killing?
P/22 – Teacher	Yes, pig is something common to children and they are well experienced with sharing of pig. To teach fraction in this lesson, pig is a very good example for children to understand, because pig has got four legs, ah two legs and two hands. And when we cut the pig and take inside part out, the whole body or skin of the pig with the legs and hands, but attached together is a good example for quarters. Therefore I choose to explain it in language (Wahgi) so that children can get it clear too.
P/23 - Researcher	Was it because it was part of children's culture?
P/24 - Teacher	yes
P/25 - Researcher	So you thought Wahgi will express it ……….
P/26 - Teacher	clearly
P/27 – Researcher	…. much easier than Pidgin.
P/28 - Teacher	yes

In this lesson the language the teacher frequently used was *Pidgin*. The teacher was teaching the concept of fraction and he came to explain that the notion of fraction is related to sharing pigs in the students' *Wahgi* culture. As he was doing that, he switched from *Pidgin* and throughout the description of the context about pigs, he was using *Wahgi*. Therefore, in paragraph 21(a), the researcher was trying to ask the teacher what made him switch and use *Wahgi* even though *Pidgin* was the frequently used language in that lesson. In paragraph 22, the teacher indicated that the sharing of pigs was part of the cultural context and to help students understand fraction, it was important not only to present the context related to pigs, but also to use the *Wahgi* language to describe it. The researcher tried to confirm by asking if he had switched to use *Wahgi* because it was part of the culture, and the teacher confirmed in paragraph 24 that he was doing that. The researcher also tried to confirm if the teacher thought that using *Wahgi* would be a best choice to express the description of pig-sharing culture compared to *Pidgin*. The teacher responded that it was and that *Wahgi* would do so clearly (see paragraph 22 & 24). Such a conversation showed that the teacher was conscious of language and the relation each language had to a context. Being a bilingual means to possess the ability to switch language purposefully, hence knowing when each language could be best used for effective communication. In this case, it was obvious that to use information related to the students' culture, the best choice of language for the teachers was the local vernacular, *Wahgi,* and not the national language, *Pidgin*.

5.5.3 Teachers Perceived Importance of Using English

As indicated earlier, three languages were involved in this study. In the earlier sections (5.5.1-5.5.2), teachers' views related to using the local languages were described. This included the purpose of their switching, the factors teachers used as signs to make a switch, and the use they made of the local languages to serve their various teaching purposes. However, to obtain a fuller understanding of the teachers' perspective regarding the language situation of mathematics lessons, there was a need to understand the teachers' views related specifically to English. This would help decide which one of the languages they perceived as most important, or whether indeed all languages were of equal importance. In the following section, the researcher describes the teachers' views related to using English.

The general impression obtained from this study was that all languages were important for the students' education. To illustrate, the researcher describes some responses teachers gave when asked for their general view about the change in language policy, and hence the official access they now had to using the local languages with English in their teaching. To do this, the researcher refers to Teacher W's response in Talk 5.13.

Talk 5.13: Paragraph 33 to 36 from Teacher W's Interview

P/33 - Researcher	Just a general question, what is your view about this introduction of new policy that allows students to use or teachers to use more than one language in their class unlike before where they normally use only one language which was English? What is your view about this? You like it or you don't like it? Is it good or is bad?
P/34 - Teacher	I cannot make any plan about this because I came through that transitional period. I did not have much idea about traditional type of teaching, but only in the modern one through the reform education…
P/35 - Researcher	I can tell you my experience that might help you. When I went to school, English was the only language and teachers use English. So to respond back to the teacher, we were expected to use English. You know what I normally do; I had no idea about English so I never spoke to my teacher. Okay, that's my experience. Your experience as a teacher now, what kind of difference do you see from my experience as I have just said. Before you would have hardly any respond from the kids. What is it like now?
P/36 - Teacher	yes, there is a big change now. When I use the known language, which is Pidgin, I see a lot of response from the students. It's not only in grade 3 but in other grades, like I taught grade 6 and 7 previously and I have this experience that most children are scared in responding with other foreign language like English. But in their own languages, they are quite familiar and there is freedom. But, there is one other problem that lies in this is, when they speak more Wahgi and Pidgin, they have problems in English. They are in the modern world, people communicate with English. If they want to get a job, they have to speak English and ….

Towards the end of paragraph 36, Teacher W clearly states the two common reasons that all teachers gave for their belief that English was important. First, it was a language that could be used to find jobs nowadays. Second, it was a language to be used to communicate with the rest of world in this modern day. He went on to say that, if the local languages are used too often, it will make speaking English more difficult. The important thing to take note was how this conversation progressed. Teacher W talks about how beneficial it was to use the local languages with respect to the responses of the students in the classroom. Before the researcher asked him any other question, he changed the topic of discussion and said that if students continued in such a language use, it will cause problem for learning and speaking English. Such a shift in talking indicated that, in the teacher's view, both the local languages and English are important, but there were limits to this situation. A similar response was recorded with another teacher, Teacher K, as shown below.

Talk 5.14: Paragraph 15 & 16 of Teacher K's Interview

P/15 – Researcher	I remember, when I went to school, English was compulsory and teachers were all speaking English all the time and we were expected to speak English too. That time as a student, I did not have the freedom to talk to the teacher because I couldn't speak English. Now is there any difference you see now when you know, the difference between the freedoms of speech, communication to children, is there any difference you see. Like, children are feeling free to talk to you or they are not feeling free to talk to you.
P/16 - Teacher	That's exactly, they feel free to talk to us. And they feel free to talk to us in Pidgin and their own 'tok ples', just as freely as a family talk to a parent. And that is good, we like it too. But, then we would like our children to speak English and that is what our heart wants.

As indicated earlier, Teacher K was one of the experienced teachers in the group. She had 20 years' experience in teaching, which meant that she taught when English was compulsory. Again, the flow of her talk is the same as Teacher W's. She indicated that using the local languages helped her students to talk freely. Before the researcher could ask a question related to the importance of English, the teacher switched from her general view about using the local languages to say that, in her heart, she wanted her students to speak English fluently. She does not give reasons as other teachers did, but obviously, she understood that English was important for finding job and communicating with the rest of the world. Therefore, she felt the need that her grade 3 students should start speaking English.

Such a view of English was confirmed in the way the three languages were used to teach mathematics as described in earlier sections 5.1, 5.2 and 5.3. As shown in section 5.2, when mathematical English terms/phrases were borrowed, they were used as noun phrases to indicate that the rest of the sentence in the local languages promoted the mathematics register, but mainly expressed in English. Similarly, the analysis in section 5.3 suggested the purpose for switching pointed towards helping students understand formal mathematics, and this was mostly expressed in English. Overall then, it seemed that teachers used the local languages to make the needed bridge for students to understand the mathematical concept being taught, but they also encouraged their students to learn the mathematical English that expressed this concept at the same time. Therefore, although both the local languages and English were important in the mathematical discourse, this study showed that the teachers' main aim was to promote mathematical English through the use of local language.

5.6 The Role of Local Languages in Teaching Mathematics

The major aim of this study was to identify the role of local languages in teaching mathematics. Therefore, this study chose to examine the role of local languages within the language practice of code-switching. From the literature it is clear that bilinguals or multilinguals code-switch and purposefully chose a language perceived to be suitable for a certain moments in a conversation to enhance communication, in this case communication embedded in a teaching process. If selecting a language was a considered act to enhance communication in the teaching process, this study aimed to identify the role of local languages by examining why one or other was selected through the purpose of code-switching. From the evidence described in the earlier sections 5.3 to 5.5, it seems appropriate to conclude that the purpose of code-switching was to guide unbalanced multilingual students to learn effectively, in this case, various mathematical concepts. However, the teachers made the choice, and in many cases they had no choice but to express the mathematical concepts to be learned in English. To promote understanding when English was introduced for the first time, as is the case in grade 3 classrooms or 'bridging classrooms', teachers believed that it was necessary to use the fluently spoken local languages *Wahgi* and *Pidgin* to assist and ease the language challenge.

Teachers firmly believed that to guide the learning of mathematical English and mathematical content effectively, they had to help students understand through the use of their local languages. Therefore, the role of local languages, *Wahgi* and *Pidgin*, was to help students understand to learn mathematical English and mathematical content successfully. The evidence lies in two categories: first, what the teachers said during interviews and, second, how the teachers used the local languages in their teaching. Section 5.5 reported what the teachers said when they were asked during interviews, why they switched and used the local language. The teachers indicated that they used the fluently spoken language of the students to help them understand the new mathematical concepts and learn the formal mathematical English as a language. Such a view was confirmed through the way the teachers used the local languages in their mathematics teaching. This was discussed in sections 5.3, through the two types of switching: intra-sentential switching (code-borrowing and code-mixing), and inter-sentential switching. To illustrate, through code-switching the teachers used the local languages to serve four purposes in order to help students understand: they were repeating, explaining, asking questions and presenting realistic context. For example, when repeating a question and giving an explanation presented in English, in order to help the students understand what the question was asking for or explanation was about, the teachers switched to one of the local languages to repeat the question. Such evidence indicated that the teachers mainly used the local languages to help students understand the mathematical concept and the mathematical English used to express the concept. On the other hand, the ways local languages were used and the ways English was presented, the teachers obviously showed that they wanted to promote English, in this case mathematical English, through the use of local language. From the evidence presented, the role of English was as a formal language of mathematics used to express mathematical concepts. The local languages were used to promote these by deploying them in a way that could help students understand the concept and the formal mathematical English.

5.7 Summary

This Chapter presented both quantitative and qualitative result. The quantitative evidence was used in this chapter as background information, but the major target was the qualitative evidence. However, from a quantitative perspective, it was found that three languages, *Wahgi*, *Pidgin* and English, were commonly used by the eight teachers in mathematics lesson. The most frequently used language was *Pidgin*, and the language combination for pairing through code-switching was most commonly between *Pidgin* and English. This study focused on the quality of use of the three languages, particularly the local languages, through the language practice of code-switching. Specifically, this study aimed to identify the role of the local languages in teaching within mathematics discourse by studying closely the language practice of code-switching. This study used two sources of evidence to determine the quality of use of the local languages: the first was from what the teachers said during interviews, and the second from the way teachers used the languages through code-switching to teach mathematics. In summary, the evidence presented here indicates that the purpose of code-switching was to guide unbalanced multilinguals to learn effectively. It was also clear from the evidence that English was used as the final form of the conceptualizing mathematics concept, and hence formal mathematical English was seen to be critical to learning. Such a role was promoted in the ways the local languages were used that gave English such a privileged place in the teachers' verbal communication during the lessons.

CHAPTER SIX PRACTICES OF CODE-SWITCHING AND LANGUAGE ALTERATION AS A TEACHING TOOL

6.1 Introduction

This research aimed to study the language-practice of code-switching within a group of multilingual mathematics classrooms. As indicated in Chapters 4 and 5, three languages were observed in this study; two were local languages: *Wahgi*, one of the local language of Jiwaka Province, and *Pidgin*, one of the national language of Papua New Guinea, and the third English. This is the second chapter presenting results from this study. The first (Chapter 5) examined the purposes of code-switching to determine the role of local languages within mathematics discourse, although it was recognized that switching also occurred within other types of discourse in each lesson. In summary, the role of the local languages in the language-practice of code-switching was mainly to promote students' understanding, particularly that of mathematical English. This chapter aims to expand the discussion of code-switching and teachers' purposes in alternating each of the three languages.

The discussion in this chapter is in two parts; the first part presents a general overview of the languages used within each lesson and makes connections to the role identified in Chapter 5. The second part of discussion aims at examining qualitative results related to practices of code-switching that enabled purposeful use of each language, in both mathematical and non-mathematical discourses. Specifically, outstanding practices of code-switching and alternating language within the conceptual discourse of mathematics are examined in detail. Similarly, since non-mathematical discourse was not part of discussion in Chapter 5, the detailed analyses of code-switching in this discourse are examined. A particular focus is given to the unique and outstanding practices of code-switching and language selection by Teacher K. This chapter ends by comparing the roles of code-switching interpreted through linguistic teaching behavior of Teacher K, with what she later said during her semi-structured interview. It was obvious that Teacher K was consciously aware of the importance of using both the local languages and English. It initially started with a tension; on one hand to use *Wahgi* to help students understand in the place of English, and on the other to use more English to help students learn English. Such a tension played a positive impact on how this teacher responded to the linguistic needs of each lesson.

6.2 Languages Emphasis within a Lesson

This section aims to explore the relationship between the amount of language used in each lesson and the role of alternated language noted in Chapter 5 through the purpose of code-switching. In Chapter 5, the leading languages were identified and presented in Appendix C: 5.3. According to the percentage of language used, and comparing them with language proportion recommended at the policy level for grade 3, the language emphases were categorized. From this study, two categories emerged. The first category involved two extremes of language-use compared to the recommendations at the policy level for grade 3. The policy recommended that in grade 3, 60% of local languages were to be used to introduce 40% of English. The first extreme involved lessons that used more than 60% of local languages and hence much less than 40% of English. The second extreme was the lessons that used much more than 40% of English and much less than 60% of local languages. The second category of language-use occurred in lessons that were close to the language proportion recommended by the policy. Such language use is described as 'fair emphases' in language-use in this chapter, compared to single emphasis for the first category. From the results, both categories of language emphases were observed from the 16 lessons. The first category is described in section 6.2.1 and the latter is described in section 6.2.2. This discussion will show that Teacher K was unique in her language use, because she promoted a variety of language emphases; aiming to promote understanding, mathematics English and general English.

6.2.1 Single Language Emphasis within a Lesson

In section 5.1 and Appendix C: 5.3, the leading languages spoken in each of the 16 lessons were identified. This section used the same results but analyzed them in terms of the emphasis placed on the language-use within the teaching process. The analysis used the frequency of the teachers' use of the possible languages and compared this with the proportions recommended by the new language policy for grade 3, as described earlier. The category discussed here were in the two extremes of using each language, in the category of single emphasis. These included a language emphasized much more or less than 60% of local language and much greater or less than 40% of English. Table 6.1 shows the lessons and the language over-emphasized.

Table 6.1. Single Emphasis in Amount of Language used.

Teacher/Lesson		Lesson Dates	Lesson Topics	Percentage (%) of Language Use				Total (%)
Teacher	**Lesson No.**			**Local Languages**		***Total***	***English***	
				Wahgi	***Pidgin***			
M	1	20/03/06	Multiplication &	57	25	82	0	82
	2	21/03/06	Multiples	16	65	81	11	92
	3	28/08/06	Fractions	53	43	96	1	97
J	1	20/03/06	Multiplication – 2	24	69	93	2	95
	2	21/03/06	Multiplication – 3	8	76	84	5	89
T	1	27/05/05	Word Problem -	17	74	91	2	93
A	1	25/10/05	Making Fractions	7	9	16	80	96

Note: The totals do not add to 100%. The difference was 'talk by children'.

From Table 6.1 the common type of language-emphasis used for teaching in this group was placing greater emphasis on the local languages compared to English. The less popular language -use emphasized English more than the local languages. According to Table 6.1, Teachers M, J and T emphasised the local languages, with only Teacher A emphasizing English. The details of language-use could be read from Table 6.1. However, to demonstrate how the readings were used, the researcher uses Teacher M as an example. In lesson 1, this teacher used a total of 82% of local languages [57% (*Wahgi*) + 25%(*Pidgin*)], but no English, in lesson 2 he used 81% of local language and 11% of English and in lesson 3, he used 96% of local language and only 1% of English. The first two lessons were observed earlier in the year (March) and the third one was observed in the later part of the year (August). However, the emphasis in language use was consistent across the year. When making connections to the summary of Chapter 5, this heavy emphasis on the local languages could suggest that these teachers aimed at promoting understanding and mathematical English only, with less focus on promoting general English. In the later sections, when the specifics of code-switching and language use are presented, the details of how such practices were used as a teaching tool will be elaborated.

On the other hand, Teacher A was the only member of the group who placed greater emphasis on English than the local languages. From Table 6.1, she used 80% of English and 16% (7% + 9%) of local languages. According to the new language policy, such language emphasis was recommended for grade 6. Since the lesson was observed later in the year in October, this teacher might have used such language emphasis later in the year, with some variation in the early months. Even so, this teacher skipped the language-use proportions recommended for grades 4 and 5, but used grade 6 recommendations. Maybe his students showed signs of understanding English well and did not need the local language to help understand mathematics content. Whatever it was, this study did not ask for the reasons and also did not observe enough lessons in different intervals of the year to draw any definite conclusions.

It is not the aim of this section to imply that disproportionate emphasis in language use is a worse or better way of using languages as a teaching tool. The only fact to observe is that this was a common practice of using the languages available. However, there is enough evidence from this study to suggest that some teachers responded to the linguistic needs of their class by changing the balance of languages if the linguistic need altered from lesson to lesson. This will be illustrated in the next section where a variety of emphases were observed in teaching through this study.

6.2.2 Variation in Language Emphasis between Lessons

As was indicated earlier, the other half of the teachers who participated in this study varied their language-emphasis between different lessons they taught. This included the single language -emphasis in their teaching as described in section 6.1.1. This meant that these teachers used the two scenarios of single emphasis in language use (emphasis on both the local language and English) and the fair emphasis in language use (using 60% of local language and 40% of English). Table 6.2 shows the Teachers and their amount of language used in each lesson.

From Table 6.2, four types of language-emphasis were observed from these four teachers in their language use. The first was common and similar to what was described in section 6.1.1. In this case, the languages commonly emphasized by the four teachers in their teaching were the combined use of the local languages. This meant that the emphasis in using the local language was much larger than 60% and English was used much less than 40%. Such an emphasis of using the local languages was found in four lessons by three different teachers in this group. This number of lessons, added to those discussed in 6.1.1, makes such language use a popular one in this study. The teachers included Teacher K, W and D. The unique thing about these teachers was that such language emphasis was in one of the lessons they taught, but, in the others, they used a different language emphasis. For example, Teacher K was among the group of teachers who used a single emphasis for lesson 2, but used other emphases in lessons 1 and 3 as described later. The specifications of their language use could be read on Table 6.2. These lessons were taught in different months of the year, but all emphasized the use of the local language more than English. This study did not ask why they used such language emphasis, but this study suggests that their lesson topic provoked such linguistic need. Therefore, it did not matter what month of the year the lesson was taught.

Table 6.2. Amount of Language used and Language Variation

Teacher	Lesson No.	Lesson Date	Lesson Topic	Percentage (%) of Language Use				Combined Total (%)
				Local Language			English	
				Wahgi	Pidgin	*Total*		
K	1	05/05/0	Addition	3	54	57	31	88
	*2	07/06/0	Measurement	13	75	88	5	93
	* 3	19/04/0	Division	0	32	32	61	93
W	* 1	21/03/0	Number words Using	0	41	41	48	90
	2	22/03/0	Fractions	2	75	77	16	93
	3	22/08/0	Shapes & Angles	6	69	75	20	94
D	1	06/05/0	Weight	12	55	67	27	94
	*2	24/10/0	Perimeter	17	63	80	12	93
G	1	08/05/0	Measurements	46	5	51	43	94

Note: The totals do not add to 100%. The difference was 'talk by children'.

The second type of language emphasis was the one close to the proportion recommended by the new language policy for grade 3. The teachers who seem to have used such a language emphasis were Teacher K and D. Teacher K taught lesson 1 in June and used 57% of local language and 31% of English. Teacher D also taught lesson 1 in June and used 67% of local language and 27% of English. The unique thing about such language-emphasis was that this teaching promoted all three languages. In the way these teachers used languages, they aimed at promoting understanding, mathematical English and general English simultaneously. This could be a model of language-emphasis which could be recommended for future teaching practices in grade 3 classroom.

The third type of language-emphasis was the one that used the frequency of languages closer to using 50% of local language and 50% of English in teaching. According to proportions recommended by new language policy as described in Table 3.2 in Chapter 3, such language proportion was recommended for grade 4. The two teachers in this group who saw the need to use such a language-emphasis in their teaching for their grade 3 student were Teachers W and G. Teacher W in his lesson 1 used 41% of local language and 48% of English. Teacher G in his only lesson used 46% of local language and 43% of English. Such language-use in teaching is also assumed to have aimed at promoting understanding, mathematical English and general English simultaneously.

The fourth emphasis of language-use observed was closer to the proportion recommended for grade 5 as described in Table 3.2. This proportion obviously placed more emphasis on English than on the local language. The only teacher who saw the need in her lesson to use a language proportion two grades ahead of her grade 3 class was Teacher K in lesson 3. She used 32% of local language and 61% of English taught in the month of April. This could be another safe language practice to promote all three roles of using language. There may have been an emphasis on promoting mathematical English and general English, but there is enough use of local language to promote understanding. Using the language emphasis meant for grade 4 and 5 is a safe practice, which also gives grade 3 students an opportunity to be exposed to the language-use for higher grades.

In the earlier paragraphs, four types of language emphasis in teaching were determined according to the amount of each language (*Wahgi, Pidgin* & English) used within the 16 lessons observed through this study. This meant that depending on the linguistic need of the lesson, teachers could respond by using any of the four language emphases. It appears that none of these four teachers had a single habitual way of using language which never varied. The teacher who stood out in promoting this view was Teacher K. From the above group of teachers using four types of language emphasis, she used three out of the four types of variations in emphasis in language use. This study observed three lessons from Teacher K, each of which had a different language emphasis. She used the single-language emphasis in lesson 2 similar to what would be used in grade 2 at the elementary schools: she used language emphasis similar to what was recommended for grade 3 in lesson 1: and she also used emphasis recommended for grade 5 in lesson 3. She showed that more than one language-emphasis could be used for grade 3, instead of only the single language proportion as proposed in the new language policy. She prepared to use language-emphasis recommended for the lower grades than grade 3 and even for higher grades too. This indicated that, depending on the linguistic need of each lesson, she deliberately chose to use the resources of languages in different amounts to achieve each respective lesson's goals successfully.

The results presented here give a general overview of language-use in a complete lesson. However, it was indicated in Chapter 4 that a lesson is composed of three different phases, serving different purposes within the overall goal of the lesson. It was the interest of this study to further examine language-use in terms of each lesson phase.

6.3 Language Emphasis within Lesson Phases

In the earlier section, language-emphasis within each of the 16 lessons as a whole was examined and connections made to what roles they may have targeted. This section will also focuses on language–emphasis, but within and between lesson phases. The three phases were introduction, body (comprising content teaching and content practices), and conclusion. This section presents three sets of results. First, the language-emphasis observed within and between lesson phase (section 6.2.1), second the signals used to indicate a shift in language-emphasis between lesson phases (6.2.2), and third the language-emphasis within discourse distinguished within each lesson phase.

6.3.1 Language Emphasized within each Lesson Phase

This section examines the language-emphasis within each lesson phase and how it might have promoted understanding, mathematical English and general English. Appendix D: 6.1 shows the amount of language used in each lesson phase. Three interesting results can be observed.

First, there was a unique language-emphasis in the content teaching for all 16 lessons in this study. It was unique because all teachers used a single language-emphasis for the body of the lesson, including the content teaching in all lessons. This meant that when scanning the language-use in content teaching across the 16 lessons, teachers' talk involved a single language-emphasis. This included lessons that used English as a general leading language for the lessons described in section 6.1. The languages emphasized in the content teaching were the local languages: *Wahgi* and Pidgin. In addition, when comparing the total amount of each language used between each lesson phase, it was observed that in content teaching more talking took place than in the other lesson phases: introduction, content practice and conclusion. The average amount of talking taking place in the content teaching, using the three languages was close to 45%. This is understandable because this was the core of the whole lesson, where new mathematics contents were taught. By placing a single emphasis on the use of local language, all teachers seemed to indicate that they all aimed at promoting understanding and mathematical English in their teaching in this part of the lesson. In addition, teachers avoided using much English in this part of the lesson. This pattern was obvious, even within the lessons that generally used English as the leading language. It will be shown later that Teacher K was one of these teachers. Her leading language for lesson 1 was English, but she deliberately shifted to use the local languages to teach content. This showed that the teachers were aware that English was introduced to most grade 3 students for the first time as a foreign language, and they did not want to confuse them by using it often in this part of the lesson. They did this to avoid causing a double problem: first, teaching a new and difficult mathematics content, and, second, in a foreign and new language, they decided to solve the language-problem by using the fluently spoken language to teach the new mathematics content.

Table 6.3. Single Language Emphasis within Lesson Phases

Teachers	Lesson	Introduction (%)			Body (%)						Conclusion (%)		
					Content Teaching			**Content Practice**					
		W	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**
K	**2**	0	8	1	9	31	1	4	17	2	1	15	2
W	**1**	0	23	3	0	4	4	4	3	1	2	17	7
	2	0	0	3	0	42	43	0	0	0	0	0	0
M	**1**	20	4	0	49	27	0	0	0	0	0	0	0
	2	0	6	0	51	36	0	4	2	0	0	0	0
	3	0	4	1	17	24	5	0	34	4	0	9	0
D	**2**	0	0	0	5	26	6	14	42	7	0	0	0
J	**1**	1	4	0	4	31	20	20	38	1	0	0	0
	2	0	10	0	3	19	2	0	34	2	5	23	1
G	**1**	5	0	3	16	5	15	28	1	28	0	0	0
T	**1**	2	5	0	3	26	1	13	31	1	0	8	0
A	**1**	0	0	22	7	4	25	0	1	11	0	5	25

Second, most lessons had an emphasis on the same language throughout the three lesson phases. This meant that the same leading language was used in the introduction, body (content teaching & content practice), and the conclusion. Table 6.3 shows these lessons from respective teachers.

From Table 6.4, 12 lessons out of the 16 lessons used such language emphasis for each lesson phases. Within this category, two groups emerged in a single language emphasis within lesson phases. The first were those that emphasized the local language as the leading language in all lesson phases, and the second was those lessons that used English as the leading language through their lessons. The majority of the lessons were in the first group. This included lesson 2 by Teacher K, lessons 1 and 2 by Teacher W, lessons 1 from Teacher

W, lessons 1 and 2 from Teacher M, lesson 2 from Teacher D, lessons 1 and 2 from Teacher J, lesson 1 from Teacher G and lesson 1 from Teacher T. Such language-use suggested that the teachers aimed at promoting understanding and mathematical English through their language-use, but with less focus on general English throughout the lesson. The lessons in the second category were those that used more English and less local language. These lesson included lesson 2 from Teacher W and lesson 1 from Teacher A. The possible purpose of emphasizing English in teaching was to promote mathematical English and general English only, but the teachers used a limited frequency of local language to promote understanding. English was a foreign language for most students and putting an emphasis on the use of English probably limited students in their understanding of the new mathematics concept. As indicated earlier, Teacher K was unique in being part of the bigger group with an emphasis on using local language during content teaching, even when her leading language was English. In this discussion, she has also been part of the teaching process that used local language as a leading language in all three lesson phase and this was found in her second lesson. It will be shown in the following paragraphs that her lessons were also part of a group that showed variation in language emphasis.

The third category of result was related to a variety of language emphasis between the three lesson phases. This meant that teachers deliberately placed emphasis on different languages for each lesson phase. From Appendix D: 6.1, only four lessons showed a variation in language emphasis between lesson phases in a single lesson. Two of these lessons were from Teacher K, and Table 6.4 shows these results.

Table 6.4. Variation in Language Emphasis between Lesson Phases

Teachers	Lesson	Introduction (%)			Body (%)						Conclusion (%)		
					Content Teaching			**Content Practice**					
		W	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**
K	**1**	0	2	11	0	33	2	0	11	13	0	17	5
	3	0	0	7	0	31	14	0	3	27	0	0	13
W	**3**	0	7	2	1	31	6	6	1	10	2	26	2
D	**1**	0	3	4	1	12	2	5	24	4	6	20	18

Table 6.4 shows lessons that used language variation between each lesson phase. This meant that different languages were deliberately emphasized in each of the lesson phases. The teachers involved in such language-use in the four lessons were Teacher K, W and D. There were not many outstanding features in the ways Teacher W and D varied in language emphasis between each lesson-phase. Teacher W emphasized English only in content practice, but the local languages dominated his other lesson phases. Similarly, Teacher D used a little bit more English at the introduction, but the local languages dominated in other parts of the lesson. The outstanding-language use that showed deliberate shift in language-emphasis was from Teacher K in her two lessons, lesson 1 and 3.

In her first lesson (From Table 5.2) the general leading language was *Pidgin* as the local language, and English was the support-language in terms of the amount of language used. However, in her introduction and content practice, her language emphasis was English, while Pidgin predominated in the content-teaching and conclusion. As it will be shown later, the introduction and content practice did not involve much new mathematics content; therefore, the language choice of Teacher K was English. However, the content teaching and conclusion involved new mathematics content; therefore the teacher deliberately shifted language emphasis from English to the local language. When making connections to the summary of roles of using languages from Chapter 5, she aimed to help students to understand new mathematics content by using more of the local language, but whenever new and complicated mathematics content was not involved, she aimed to promote English, both mathematical and general English. A deliberate shift of language was evident in her third lesson. In lesson 3, her general leading language was English, and the local languages were used as supportive language in this lesson. It was evident at the introduction that she used English as the leading language. However, she seemed to be conscious that, whenever she had to deliver new mathematics content, she needed more local language to help her students understand. Therefore, in lesson 3, even though the general leading language of the lesson was English, she deliberately shifted to place emphasis on the local languages in the content-teaching. In the rest of the lesson phases, she returns to using English as the leading language.

Teacher K was not only unique in using a variety of language emphases, responding to linguistic needs of her individual lessons, but she also used rare signals in the way she used language and talked to indicate to her students that she was going to change her language-emphasis in her teaching. The following section describes this qualitative result, in order to strengthen the view generated from the quantitative result that she was an outstanding teacher in her language-use to promote understanding, mathematical English and general English.

6.3.2 Signaling a Shift in Language Emphases between Lesson Phases

One of the ways Teacher K was unique compared to the other seven teachers was that she seemed to signal to her students any change in language emphasis. This was observed in her ways of using languages and ways of talking. This approach occurred commonly at the end of each lesson phase, specifically at the end of the introduction, content teaching and content practice. It was indicated that most lessons used the same leading language for all lesson phases. The only four lessons that used different language for each lesson phase and would possibly signal their students a shift in language emphasis were from Teacher K, W and D. Through careful analysis, Teacher W and D showed no such ways of signaling to their students a shift in language emphasis, but it was obvious in Teacher K's talking. Such linguistic behavior was evident in all of her three lessons and commonly used in the shift between lesson phases.

The common practice observed from Teacher K was changing language as soon as the she made the announcement that they would move to the next lesson phase. This was accompanied by a pause before the teacher started using the new language of her choice. But she did not move immediately to serious talk. She first repeated what was going on earlier or she gave a brief snapshot of what was going to happen next. This study did not ask why she behaved this way, but for now it is assumed that the teacher wanted to give students time to prepare mentally for the shift in language emphasis before she went on with serious talking related to next lesson phase with a different language emphasis. This could be a natural linguistic behavior of bilingual or multilingual conversation to signal a change in language in a classroom situation, but it will be left to any future investigation and this is not the focus of this study. To illustrate, Talk 6.1 is a conversation that took place in lesson 1 of Teacher K's teaching, between the end of the introduction and beginning of the content teaching.

Talk 1. Teacher K Signaling a Shift in Language Emphasis after a Lesson Phase

	English/Pidgin	Translation
33. Tr	a. But I didn't hear the word 'and'. You didn't spell the word 'and' behind this hundred. Okay, good, you are nearly correct? We'll go on to our next lesson for today. b. Okay, yupela wokim pinis ah?	33. Tr. a. But I didn't hear the word 'and'. You didn't spell the word 'and' behind this hundred. Okay, good, you are nearly correct? We'll go on to our next lesson for today b. Okay, did you complete it?
34. Chn	yes	34. Chn. 34
35. Tr	Yupela bin wokim pinis na isave gut long en. Tru?	35. You have done it already and you know well. True?
36. Chn	yes	36. Chn. yes
37. Tr	Yes okay, em ino nupela exercise long yumi, yumi save wokim pinis. Em hamaspela number istap, em ya?	37. Yes Okay, it is not a new exercise for you, we have already completed them. How many numbers are here, this one?
……		…….
69. Tr	Okay nau, yumi laik kam long how long wokim plus ya. Yu save pinis tasol mi laik tok gen. Yumi start long, okay mi laik tok olsem, yumi stat long left, eh em rait han bilong mi, mi gat left handed, mi save rait long left han na yupela save rait long em we? Emhan kais bilongyu or … nim angek woiro ….okay han tru bilongyu or hantru or we, han, right han bilong yu ah stap long, stap long Banz side or yumi tok Wahgi side ah?	69. Now, we want come to how to do addition (plus). You know it already but I want to talk again. We start from, I want to say that, we start from left, eh it is might right, I am left handed and which hand do you write with? This is our right hand …right hand … where your right hand is , it is towards Banz or Wahgi side.

Before paragraph 33, the teacher was revising with students how to spell number names presented in numerical form. As indicated in Table 6.4, English was the leading language at the introduction of this lesson, so most talking was taking place in English until paragraph 33a. As soon as Teacher K was concluding, she announced in the last sentence that they would move on to the next lesson for the day; she was referring to content teaching. What was interesting at the end of this announcement was that she switched to *Pidgin*. It was even more interesting that in the first sentence in paragraph 33b, the language may have changed to *Pidgin,* but she did not start the main topic of the next lesson part. Instead, she made some comments about what happened earlier and did some more revision related to the new lesson content. In paragraph 33b, she commented that they had finished, by which she was referring to the revision, and in paragraph 35 she continued to comment that they had done this before and they knew it well. She was repeating the comment in the first sentence of paragraph 37 and in the last sentence she went on to do some more revision but this time it was related to the next lesson part (content teaching). She was revising the students' previous knowledge on place value and she was referring to three digit figures written on the board for content teaching. This conversation continued until paragraph 69, which is presented above, where she finally said that they will go on to practice how to do addition, which was the main content to be taught for that lesson.

As indicated earlier, there are two interesting things happening in this conversation: first the language switched as soon as the teacher announced a change of lesson part and, second, the teacher did not go straight to the next topic, but took some time using the language she just switched into to comment or revise before actually doing what she said she would do. The sample of talk included above was from lesson 1, but the pattern was apparent in the other two lessons Teacher K taught and observed by this study. This behavior was not obvious to the researcher at the time of data collection, and, therefore, he did not ask Teacher K during the interview why she used such linguistic behavior. This could be a hint for future study to ask teachers if this happens in order to to establish the teacher's perception of this behavior. For now, from the researcher's experience as a multilingual, such a delay was a skill learned by a multilingual that allowed her to communicate with young people who had less fluency in any language and were slower in understanding. When the teacher slows down, it gives students hints for a change in language emphasis and that time is meant to be used by students to adjust mentally to the shift in the language emphasis which will be used in the next part of the lesson. This evidence, related to how the teacher talked to signal a change in leading language, complements the evidence provided earlier related to which language was chosen as the preferred language for each lesson part. This meant that when Teacher K wanted to shift from introduction to content teaching, she announced that she would do so, followed by switching from English to *Pidgin* as a leading language. After teaching the content mainly in *Pidgin,* she announced that they would move on to content practice to allow students to attempt practice exercises; she then shifted from *Pidgin* as a leading language to English. Such a procedure was used for the lesson conclusion where the language was switched from English to *Pidgin*. Such shift of language-emphasis aimed to promote understanding, mathematical English and general English effectively in different parts of the lesson phase through different choice of language. It did not only serve these roles but served the purpose of each lesson phase too. Such a complex of purposes and decisions to use language through code-switching appropriately made this study regard Teacher K as outstanding.

The description of language-emphases and their related roles in each lesson phase presented earlier will become much clearer and more precise when discourses within each lesson phases are identified and their related language emphases are distinguished. This is done in the following section.

6.3.3 Language Emphasis within Discourses

To determine language-emphasis within each discourse in each lesson phase, it was important first to determine the purposes of talk observed within each lesson-phase as discussed above in terms of discourse. The purposes of talking in each lesson phase were different, although each served the overall goal of the overall lesson. The common purposes of talking observed in the introduction for all lessons were greetings, revising contents from previous lessons, introducing and defining lesson topics and managing students' behaviors. The aim of talking in the body of the lesson was divided into two parts: as content teaching and content practice. In the content teaching, talk mainly related to teaching new mathematics concepts and maintaining classroom control. In the content practice, students were provided with some tasks to practice the skills taught in content teaching. During this time, teacher attended to individual students, explaining, giving instructions and maintaining control over the classroom. In the conclusion, the teacher corrected the tasks attempted in content practice, summarized the lesson, reinforced the main content and prepared students for the next lesson.

Generally from Table 6.5, in the introduction the talk that related to revising content and introducing the lesson topic was related to mathematics discourse, while greetings and maintaining classroom control were related to non-mathematics discourse. Similarly, in the body, where new contents were taught and explained, it involved mainly mathematics discourse, but talk that aimed at presenting realistic contexts and managing behavior was related to non-mathematics discourse. In addition, in the content practice, the teachers' talk at one-to-one basis to explain and give further instructions was related to mathematics discourse and talk that aimed at presenting realistic contexts and maintaining classroom management was related to non-mathematics discourse. In the conclusion, the talk related to correcting tasks, summarizing and emphasizing the taught content would be related to mathematics discourse, but the talk that aimed at maintaining classroom control and getting students to prepare for next lesson was related to non-mathematics discourse.

Table 6.5. Types of Discourses within Lesson Phase

Lesson Parts		Discourse
Introduction		• Mathematics Discourse - Procedural discourse - **Conceptual Discourse** • Non-Mathematics Discourse - Regulatory discourse
Body	**Content Teaching**	• Mathematics Discourse - Procedural Discourse - **Conceptual Discourse** • Non-Mathematics Discourse - Regulatory Discourse - Contextual Discourse
	Content Practice	• Mathematics Discourse - Procedural discourse • Non-Mathematics Discourse - Regulatory discourse
Conclusion		• Mathematics Discourse - Procedural discourse - **Conceptual Discourse** • Non-Mathematics Discourse - Regulatory discourse

As indicated in Table 6.5, the analysis also aimed to examine the specifics of mathematics discourse in terms of procedural and conceptual discourse and non-mathematical discourse in terms of regulatory and contextual discourse. In terms of mathematical discourse in each lesson phase, the conversations that were focused on procedures related to calculations were identified as procedural discourse and conversations that focused on both calculation procedures and reasons for using such procedures were categorized as conceptual discourse. On the other hand, conversations in each lesson phase that aimed at controlling both physical and mental behavior were regarded as regulatory discourse and the conversations that focused on the context of the mathematical task, mainly found in word problem, were regarded as contextual discourse.

The aim of examining the purpose of talking in each lesson phase, and then categorizing them in terms of discourse, was to place a language tag on each so that connections could be made to roles specified in Chapter 5. Table 6.6 shows the language emphasized within each discourse across the three lesson phase observed generally from all teachers through this study.

Table 6.6. Most Frequently Used Language in Each Discourse.

Discourse		Leading Language in Each Lesson Phase			
		Introduction	***Body***		***Conclusion***
			Content Teaching	***Content Practice***	
Mathematics Discourse	**Procedural**	Local Languages	Local Languages	Local Language	Local Language
	Conceptual	Local Languages	Local Languages	Local Language	Local Language
Non-Mathematics Discourse	**Regulatory**	English	English	English	English
	Contextual	Local Languages	Local languages	Local Languages	Local Languages

In the earlier section, in Table 6.5, it was shown that both mathematics and non-mathematics discourse were present in all lesson phases. This meant that both discourses were found within introduction, content teaching, content practice and conclusion. Table 6.6 shows the language-emphases within each discourse. Table 6.6 shows that the local languages were used distinctively as a leading language within mathematics discourse both within procedural and conceptual discourse, in all lesson-phases. Similarly, for non-mathematics discourse, English was distinctively the leading language in regulatory discourse across all three lesson–phases, and local languages were the leading language within contextual discourse in all lesson-phases. When each lesson phase is considered, in the introduction, when the local language was used as a leading language for mathematics discourse, through code-switching English served as the leading language for regulatory discourse. In addition, whenever a context related to mathematics content had to be presented in the introduction, this was done mostly in a local language. In the content teaching, while the local languages were used frequently for mathematics discourse, both for procedural and conceptual discourse, English was also used through code-switching for regulatory discourse to guide students mentally and physically. In addition, whenever a context related to content was to be presented as part of word-problem, the local language was frequently used. In the content practice, while local language was used frequently for mathematics discourse; both procedural and conceptual, English was used frequently for regulatory discourse, and the local language was used frequently for contextual discourse, as part of non-mathematics discourse. In the conclusion, when the local language was used frequently for mathematics discourse, both as part of procedural and conceptual discourse, English was used as a leading language in regulatory discourse and the local language was used as a leading language for contextual discourse.

It was also interesting to compare such language-use within discourse with the frequency of language-use as indicated in section 6.1. Specifically, the local languages may not have been used frequently in the introduction and content practice, but when examining the talk in terms of discourse, they were used frequently for mathematics discourse in these parts of the lesson. On the other hand, English was used frequently in the introduction and content practice, but was used only for regulatory discourse. Similarly, English may not have been used as frequently as the local languages in the content teaching and conclusion, but it was used frequently for regulatory discourse in every lesson phase. Such a distinctive use of language for each discourse within the talk was common for all teachers in their teaching.

Such language-use in each discourse could then be related to the purposes of code-switching and of alternating language. Chapter 5 summarized roles only from within mathematics discourse. It was indicated that the purpose of code-switching practices and role of alternating the local languages were to promote understanding, mathematical English and general English. However, the purposes of code-switching within non-mathematics were not examined in Chapter 5. It is examined in this Chapter in section 6.4, aiming to show that the obvious aim of using English was to promote English, both mathematical and general English and classroom management. English was used as a language of authority mainly to control both mental and physical behavior in the classroom.

6.3.4 Code-Borrowing with Mathematics Discourse

It has been indicated earlier that the languages emphasized within mathematics discourse were the local languages, particularly *Pidgin*. In most cases, local languages were used to teach mathematical content. There is a possibility for readers to ask how, in such a language context, did teachers promote mathematical English, and it seems to be one of the main aims of teaching. Since the frequently used languages were the local languages, the most popular way of teaching mathematical English was through code-borrowing. Appendix C: 5.5 shows the terms/phrase borrowed within sentences constructed in each of the local languages within each of the 16 lessons. Since English was a foreign language, teachers in this study aimed to teach mathematical English by first focusing on teaching the phonics and semantics of mainly mathematical terms in forms of words/phrases, and limited to a few complete formal sentences in English, expressing mainly definitions. This is normally a routine to teach a child a new language. First, start with letters and their sounds, then important words with their sounds and meanings and then construct a sentence eventually. The ways teachers presented new material in these mathematical lessons are no different.

To support this view, during this study occasions were observed when some teachers used terms or phrases from the mathematics registers expressed in one of the local languages. However, the way these terms and phrases were used, compared to the way terms and phrases from the mathematics register in English were used, clearly showed that talk in the local language within the teaching process was aimed specifically at promoting mathematical English. The terms/phrases expressed in the local language, if used, were used to support and promote those expressed in mathematical English. One example will be given.

There were times when a teacher wished to use a mathematical term or phrase, and it could be expressed either in a local language, or in English. For instance, Teacher K was able to contrast the phrase '*si tuak*' in the local language *Wahgi* to mean the same as 'addition' in English (see Talk 6.2). The way she used the two terms in her teaching showed that this teacher aimed to promote the term 'addition' in English, but used '*si tuak*' in the local language as a resource. As the lesson progressed, the phrase '*si tuak*' was used by students to reflect on their understanding of the meaning of the term 'addition'. This phrase was used by students when the teacher asked if the students could give her a term/phrase in *Wahgi* that meant the same as 'addition'. This was a revision task and required students to reflect on their prior cultural knowledge and make connections with meanings of the new concept, but expressed in English. As soon as the teacher realized that the students understood what addition was through the use of an equivalent expression in the fluently spoken local language from their cultural background, she continued the talk in *Pidgin* but borrowed the term 'addition' from English, and discontinued use of the expression '*si tuak*' from *Wahgi*. The teacher verbally told the students that they would need to learn and remember the term ‘addition’ in English, which meant the same as ‘*si tuak’* in Wahgi. In effect, as soon as the *Wahgi* phrase‘*si tuak’* had served its reflection purpose, and the teacher was satisfied with the students’ understanding, the *Wahgi* phrase was not used again in the verbal communication that followed. To emphasis this point, the phrase ‘*si tuak’* was never code-borrowed within any sentence constructed in English. Such ways of talking showed that even when there were mathematical terms and phrases available in the local languages; they were not the focus of the teaching process. The focus in mathematics discourse was to promote mathematical English.

6.4. Unique Practices of Code-Switching in Mathematics Discourse

The entire Chapter 5 focused on the practices of code-switching and alternating language that enhance mathematics discourse. However, the discussions did not explicitly distinguish the specifics of how the practices of code-switching and alternating language enhanced procedural and conceptual discourse within teaching process. In fact, detailed analysis showed that most lessons observed in this study engaged in procedural discourse, with a few lessons undertaking conceptual discourse.

Chapter 5 aimed to highlight the common qualitative results within mathematics discourse. Code-switching and alternating languages within procedural discourse were discussed in detail. What was not discussed was these practices within conceptual discourse, because it was a less common discourse. However, according to the literature reviewed in Chapter 2, it was clear that conceptual discourse is highly valued in mathematics (Adler, 1996; Moschkovich, 2002; Setati, 2003; M. Setati, 2005; Sfard, Nesher, Streefland, Cobb, & Mason, 1998). This was the case because conceptual discourse involves more than focusing on calculation procedures, one of the targets of procedural discourse. Conceptual discourse looks to provide reasons for using certain procedures. This involves students articulating, sharing, discussing, reflecting upon, and refining their understanding of the mathematics that was the focus of the interaction. This will involve students actively, in this case talking to learn.

When the old language policy was in place in PNG, students could not talk because they were expected to do so only in English, a foreign language. Hence talk for the most part was not possible for students in the lower primary school. Now that the policy has changed, it is expected that teachers should create stimulating environment for students to talk as part of reflection, sharing, discussing and articulating to redefine their own understanding. This study found that this was still a less targeted method of teaching. Since conceptual discourse is highly valued but less talked about in Chapter 5, this section aims to focus on the practices of code-switching and alternating language that enhanced this discourse.

Among the few lessons that attempted to engage in conceptual discourse were those given by Teacher K. Therefore, her approaches will be examined in detail and briefly compare with others who attempted to engage in conceptual discourse. To illustrate, two characteristics of conceptual discourse found in Teacher K's teaching were selected to show how she used the practices of code-switching and purposefully alternated languages to enhance such discourse, promoting deeper understanding of mathematics content and the related mathematical English. The first related to a conversation that involved students in reflecting on definitions of mathematics registers, and the second was a conversation that encouraged students to discuss the reasons for using certain procedures in their calculations. The first is described in section 6.3.1, and the second is discussed in section 6.3.2.

6.4.1 Reflection as Part of Conceptual Discourse

As indicated, conceptual discourse was rare, but Teacher K conducted such discourses in her lesson effectively. To illustrate, this section will examine a particular conversation that sought to involve students in reflecting on and refining their understanding of a particular definition by matching the concept with an equivalent from the students' cultural knowledge expressed in their local language. The example chosen for discussion was from the introduction of lesson 1, where she was introducing the lesson's topic and also tried to reflect on the definition of the lesson topic. To show that she was unique, the purpose of talking in the introductions from all 16 lessons, are summarized in Appendix D: 6.2 for comparison purposes. From this Table, it is shown that in the introduction phases of the 16 lessons, introducing the lesson topic seemed to be a common practice, but extending the conversation to define the lesson topic occurred in only two lessons; one taught by Teacher K and the other by Teacher W. However, between them Teacher K was the more outstanding because she aimed to reflect on the definition while Teacher W aimed to transmit the definition, requiring students to remember and recall what was transferred. As indicated earlier, conversations that involve reflection were regarded as conceptual discourse, whereas transmitting definitions was part of procedural discourse. However, Teacher W's practices are included in this discussion because some of his approaches had the potential to transform the conversation from procedural to conceptual discourse. As part of the comparison, the following paragraphs will show how Teacher W came close to having a conceptual discourse. To illustrate, sample of the introductions that covered defining lesson topics from both Teacher K and Teacher W are presented below side by side as Talk 6.2 and Talk 6.3.

The conceptual discourse began for Teacher K towards the end of paragraph 5 and ended at the beginning of paragraph 7. Similarly, Teacher W's attempt at a conceptual discourse began at paragraph 3 and ended in paragraph 15. As indicated earlier, both cases involved introducing the lesson topic and aimed to get students to learn the relevant definitions. The lesson topic Teacher K introduced was 'addition' and the lesson topic Teacher W aimed to introduce was 'fraction'. The way they progressed in their talk in teaching to achieve a successful conceptual discourse differed and the comparison of their difference will be the centre of this discussion.

There may have been other factors that might have caused the difference, but the centre of this discussion are the practices of code-switching, alternating languages, and the related teaching-practices used within these conversation, which is categorized as conceptual discourse. In the following paragraphs, the practices of both teachers will be described separately and their differences/similarities in teaching practices will be compared later. Before the conceptual discourse began, both teachers started the lesson differently. Teacher K began her lessons by greeting her students (paragraph 1-4) and Teacher W began with a realistic context that related to sharing a piece of pork meat (paragraph 1) related to the lesson topic on fraction. The conceptual discourse of Teacher K started in paragraph 5 and the details are described in the following paragraphs. The attempted conceptual discourse of Teacher W started in paragraph 3 and will be described in the paragraphs that follow.

Talk 6.2. Teacher K's Talk at the Introduction of Lesson 1.

English/Wahgi/Pidgin

1. Tr. Okay, good afternoon grade 3.
2. Chn Good afternoon Mrs Kupun and Friends.
3. Tr How are you all this afternoon?
4. Chn We are very well thank you.
5. Tr Okay, we'll go into our Maths lesson again, after lunch today. Okay, this morning we have been working with addition, or plus … or tok ples yumi tok wanem?
6. Chn plus, si tuak, bil
7. Tr. Oh, si tuak ….. Ating ol dispela words yupela i usim long Elementary ah, nice….. Okay, ….. in English we say addition or plus. Okay, we'll ah, and at the same time we have been working with ah, number words. Okay, now we'll have some revision exercise here and then we'll go on to our real Maths lesson for this afternoon. All fold your hands, sit up straight. Okay, this is revision exercise. Change the figures to number words. That's what we have learnt this morning. Okay, I have got some, number or figures here, A, B, C, D and E. Okay, first one is number 16. We would like to change this one to number words. Who would like to spell number 16 for me, by looking at this, ah ah the words here that I have put up this morning? Yes, very nice Carol. Spell number sixteen for me in number words.

Translation

1. Tr. Okay, good afternoon grade 3.
2. Chn. Good afternoon Mrs Kupun and friends.
3. Tr. How are you all this afternoon?
4. Chn. We are very well, thank you.
5. Tr. Okay, we'll go into our Maths lesson again, after lunch today. Okay, this morning we have been working with addition, or plus … Or in Wahgi (tokples), what do we call it?
6. Chn plus, put together, heap them
7. Tr. Oh, put them together, …I think you used this word in Elementary schooling ‘’’ Okay, ….., in ENglish we say addition or plus. Okay, we'll ah, and at the same time we have been working with ah, number words. Okay, now we'll have some revision exercise here and then we'll go to our real Maths lesson for this afternoon. All fold your hands, sit up straight. Okay, this is revision exercise. Change the figures to number words. That's what we have learnt this morning. Okay, I have got some, number or figures here, A, B, C, D and E. Okay, first one is number 16. We would like to change this one to number words. Who would like to spell number 16 for me, by looking at this, ah ah the words here that I have put up this morning? Yes, very nice Carol. Spell number sixteen for me in number words.

Talk 6.3. Teacher W's Talk at the Introduction of Lesson 1

In Pidgin and English

1.	Tr	…… sampela meat ol givim long inside long haus, yu save, em yu yet yu boss long dispela haus na papa na mama ol cutim meat na ol givim pinis, em yu bai tok, em mi less, yu bai tok olsem, em husait bai kaikai, ah. Yu bai laikim meat tasol, oh yu bai makim pastaim ah, yu bai tok, daddy bun ya bilong mi, Yupela save tok olsem oh nogat?
2.	Chn	yes
3.	Tr	Okay, nau lukim long black board. Nau long dispela morning, yumi bai gat Maths lesson. .. And the topic is, who can, who can pronounce this word? Hands up,.. em ya .. who would like to pronounce it. Mila
4.	Mila	Fraction
5.	Tr	Everybody say, fraction.
6.	Chn	Fraction
7.	Tr	Yupela save harim dispela word pastaim ah? … Piltanjipmo?
8.	Chn	Na piltanjin
9.	Tr	Ma, ma mo? …all say Fraction
10.	Chn	Fraction
11.	Tr	Spell the word.
12.	Chn	f r a c t i o n , fraction
13.	Tr	Okay, what is a fraction? … Fraction em wanem samting? …Meaning bilong em olsem … a small part of a thing. A small part of a …
14.	Chn	thing
15.	Tr	Thing. … Em mining bilong en. …..

Translation

1.	Tr.	--- when some people come to your house and give some pork meat, you are the only child in the house so you will be requesting the best part of the meat. Do you do that?
2.	Chn	yes,
3.	Tr.	Now, look at the board. Now, in this morning we will have mathematics lesson. And the topic is, who can pronounce this word? (as he points on the board at the term fraction). Hands up .. this one … who would like to pronounce it. Mila
4.	Mila	Fraction
5.	Tr	Everyone say fraction
6.	Chn	Fraction
7.	Tr	Have you ever heard this word before? … have you ?
8.	Chn	No, we never heard
9.	Tr	Is it No… Say fraction
10.	Chn	Fraction
11.	Tr	Spell the word
12.	Chn	f r a c t i o n, fraction
13.	Tr	What is a fraction? … What is a fraction? It means … a small part of a thing. A small part of a …
14.	Ch.	Thing
15.	Thing	… that's its meaning.

In paragraph 5, Teacher K introduced the lesson topic and started the conversation that aimed at reflecting on its definition. In the first sentence from paragraph 5, she started by saying that they will go into their mathematics lesson again (which meant that this was the second lesson of the day) on the same topic. In the second sentence in paragraph 5, she indicated that this morning they were (looking at) working with addition or plus. The talking so far from paragraph 1 to two first sentences in paragraph 5 was conducted in English. At the end of the second sentence, where the lesson topic was introduced, she switched her language from English to *Pidgin* to construct the third sentence. The third sentence was a question. The question itself was interesting because, in *Pidgin*, Teacher K asked the students to tell her a word or a description in *Wahgi* language that meant the same as addition/plus. The skill asked for through this question was obviously reflection. It required the students to reflect on the known cultural knowledge with corresponding new knowledge and, even better, they were asked to express this in the local language. By correctly matching a concept from the known cultural knowledge, students would show the teacher their understanding of the new concept. In paragraph 6, students gave her some responses. They were; plus, *bill* and '*si tuak'*. These responses gave the teacher the best opportunity to judge her students' understanding or misunderstanding related to the term 'addition'. Now that she received three different answers, one in English and two in *Wahgi*, she had to decide which of the two *Wahgi* responses she would approve or disprove. As indicated in Chapter 4, Teacher K was a local and she understood the *Wahgi* concept related to addition before she posed the question as part of eliciting (Mercer, 1995). Teacher K already knew that '*bill*' meant to group them or heap them together and '*si tuak'* meant to take it in or bring them together. Both responses were almost perfect, but the teacher had to approve one of them for the class to share as common knowledge. She did that at the beginning of paragraph 7, where she repeated '*si tuak*' to indicate that she approved this definition. As indicated in Chapter 5, and as will be shown later on Table 6.6, repeating a student's response was a common practice in all lessons observed, and it seem to imply to the students that whatever the teacher repeated was approved. Such a practice was seen here in Teacher K's teaching and it will be also obvious later in Teacher W's teaching. After repeating the expression '*si tuak'*, she switched to Pidgin in the second sentence in paragraph 7 and commented positively that they learnt this words/expression (referring to '*si tuak'*) in their elementary schooling and congratulated them for giving an accurate answer to her question. She switched to English in the third sentence in paragraph 7 and summarized the talk. She orally made the connection with the understanding expressed in *Wahgi* with the term 'addition' in English. In the third sentence after switching from *Pidgin* to English, she implied that for '*situak*' in *Wahgi*, we say 'addition or plus' in English.

This statement completed an apparent cycle of conversation that would be regarded as characteristic of a successful conceptual discourse. From this study, it seemed that the cycle began when the teacher introduced the lesson topic, and then posed an important question as part of an eliciting that directly required the skills of reflection. Then giving time for students to reflect and respond to such questions, the teacher had to wait or ask more leading questions until she received the correct response from her students. Then the teacher needed to approve the student's response by repeating what the students said, and finally she makes the connection between the students' response and the concept in focus, in this case 'addition' in English. Furthermore, both the teacher and her students had to fulfill particular responsibilities: the teacher took up the job of a facilitator and the students were actively involved in reflection and in talking to express their understanding of addition.

The major focus of this section was to examine how Teacher K used the practices of code-switching that might have enhanced the effectiveness of conceptual discourse. There were a number of code-switching episodes taking place in the conversation described above from Teacher K. The first and the most important code-switching moment took place in paragraph 5, between the second-last and the last sentence. The type of code-switching involved here was inter-sentential, where languages were shifted at the end of a sentence or paragraph. The language was switched from English to *Pidgin*. The purpose of switching was to ask a question that was responsible for getting students to reflect as part of the conceptual discourse. The role of using *Pidgin* to ask the question was to help students understand that they were asked to reflect, by distinguishing cognitively a local cultural concept that meant the same as the concept of addition. The teacher as a local had some idea what were some cultural concepts. Such questioning technique used by Teacher K, where she had some idea of the answer to the questions asked but aimed to check what the students know, was described by Mercer (1995) as eliciting. Part of the question asked the students to express the matching cultural concept related to addition in *Wahgi* and the students did with two suggestions: '*bill*' and '*situak*' in paragraph 6. In order to approve one, the teacher had to do the second code-switching. She switched from *Pidgin* where she last asked the question to

Wahgi to respond to the students' response at the beginning of paragraph 7. This was one of the common practices of talking observed in all of the lessons observed in this study. It seemed that all teachers seem to repeat those student responses that they approved. In addition, whenever a language to be used was not specified by Teacher K, it was understood that the language she last used to ask the question was the language in which the students were supposed to respond to their teacher. As soon as she approved the students' response in *Wahgi*, she did the third code-switching, where she made comments and congratulated them for accurately reflecting the concept of addition in *Wahgi* using cultural concepts. The final code-switching that completed the cycle of conceptual discourse was where she switched from *Pidgin* to English, where she made the formal connection between the concepts expressed in *Wahgi,* with 'addition' expressed in English. The roles of local language used through code-switching in this conversation within such conceptual discourse promoted deeper understanding of the concept of addition and enhanced meaningful learning of mathematical English, while the English language aimed to promote both mathematical and general English.

Teacher W's attempt to introduce the lesson topic began in paragraph 3, after presenting a realistic context related to fraction in paragraph 1. The first sentence in paragraph 3 asked the students to look at the board. This talk by the teacher was conducted in *Pidgin*. However, he switched to English for the second sentence as he introduced the lesson's topic. He started a statement by saying; 'the topic is…', but completed with a question. As he was saying what the topic was, he simultaneously pointed at the word 'fraction' written on the board. The process of code-switching was taking place where the teacher switched from *Pidgin* to English. Since the shift occurred at the end of a sentence, the type of code-switching was inter-sentential. The ways of talking included an incomplete statement and a question. The purpose of these ways of talking aimed to introduce the lessons topic and to get the students to pronounce the word 'fraction' correctly. Obviously, the role of using English here was to promote English, both mathematical and general English, but the conversation did not aim at helping students understand the concept of fraction. The request to get students to pronounce the word continued and finally the teacher asked Mila to say the word. In paragraph 4, Mila successfully pronounced the word. The teacher approved by asking all students to repeat the term 'fraction' in paragraph 5, and all did in paragraph 6. This conversation obviously involved the teacher introducing the lesson's topic and students being taught to read and pronounce the term ‘fraction’ correctly, but students were not given the opportunity to reflect on the concept of fraction.

However, there were two moments in the later part of this conversation that had the possibility of Teacher W extending the conversation further to reflect on the concept of fraction. The first moment was observed in paragraph 7. The teacher returned to using *Pidgin* from English and asked a question that could have started the reflection on the lesson’s topic. He asked the students in *Pidgin* whether they have ever heard this term (‘fraction’) used before. He said; ‘*yupela save harim dispel word bipo*?” (Have you ever heard this word before?) He repeated this question again in *Wahgi*. He said, ‘*Piltanjipmo*?’ This single word asks the same question asked in *Pidgin*. If the term is split into parts; *pilt* – means the same as hearing or heard; *tanjip* – meant the same as ‘have you ever’, *mo* -is the questioning sound that is always attached as suffix to the end of a word or statements that make them become a question. The expression can be read as; ‘have you ever heard about it?’ As indicated earlier, it seemed common in all lessons that the students seemed to use the last language their teacher used to response in any questions asked, if they were not asked to use a specific language. The teacher’s use of the language to ask the question must tell the students indirectly that this is the language they should use if a specific language was not asked for. In this case, Teacher W started the question with *Pidgin*, but he switched to *Wahgi* to ask the same question, and, in paragraph 8, the students responded in *Wahgi*, but not in *Pidgin* or English. They indicated that they never heard the word. They said’ ‘*na piltansjin’*, (which means ‘we never heard about it’). This could be regarded as a genuine and honest response because they were able to do so with no language problem or hesitation. Therefore, the teacher was given the best opportunity to access the students’ lack of knowledge. This response may have answered the question of whether they had ever heard or used the term ‘fraction’ before. But this did not necessarily mean the students were not aware of the *concep*t of fraction. This was the moment the teacher could have made the connection to the realistic context he presented in paragraph 1. Instead, the teacher accepted literally that they had never heard the term. However it seems his driving aim was to expose them to the correct pronunciation and spelling. Therefore, in paragraph 9, the teacher came up with a question-like statement expressing his acceptance that the students indeed did not know, by saying ‘ma mo’ which could be read as ‘is it no!’; where *ma* means no, and *mo* is the sound of questioning. This showed that the teacher believed literally what the students said; that they had never seen or heard the term before. He therefore switched to English in the second sentence of paragraph 9 and asked the students to practice saying ‘fraction’ and spell it correctly in paragraph 11. The students repeated the term in paragraph 10 and spelt the term in paragraph 12. The second opportunity the Teacher W had in his teaching to reflect on the concept of fraction took place again in paragraph 13. He began in this paragraph by asking the students what a fraction was. This was conducted in English. In the second sentence of paragraph 13, he switched and repeated the same question in *Pidgin*. Instead of waiting for the students’ response as part of reflection, he answered the question himself in the third sentence of paragraph 13. He starts in *Pidgin* by saying, “the definition of it is”, then switched to English to express the formal definition of fraction; ‘a piece of a thing’. In the last sentence, he repeated and paused for the students to complete the sentence by saying the last word of the definition (thing) and the students responded by saying ‘thing’ in paragraph 14. The teacher in paragraph 15 repeated the response to confirm and concluded that this was the meaning of ‘fraction’.

There were three types of code-switching taking place in Teacher W’s verbal communication. The first one was inter-sentential, where the teacher switched after a sentence was completed in English to using *Pidgin* to repeat the question. The way of talking and also the purpose of talking were both related to repeating a question. The role of *Pidgin* used here was to help the students understand the question and successfully reflect on their cultural knowledge corresponding to addition. The second type was code-borrowing; it was intra-sentential switching in the question asked. The question was constructed in *Pidgin* but borrowed the term ‘fraction’. From Talk 6.3, Teacher W said in the second sentence of paragraph 13; fraction *em wanem samting*? (“fraction, what is it?”), which would be understood as “fraction, what thing is it?” The term ‘fraction’ was borrowed from mathematical English used within the grammatical rule of the sentence, where it formed the noun phrase and the rest of the sentence in *Pidgin* formed the verb phrases. Such grammatical arrangement showed that the rest of the sentence constructed in *Pidgin* was promoting the term ‘fraction’. As it was indicated in Chapter 5, the practice of code-borrowing was used frequently where the leading languages were the local languages: *Wahgi* and *Pidgin*, which were used mainly in content teaching and conclusion. This was used successfully to teach mathematics content and mathematical English. The third type of code-switching was code-mixing from the intra-sentential switching category. This involved the teacher using two languages to complete a sentence. In fact *Pidgin* was used to start the sentence and English was used to complete the sentence. The purpose of using *Pidgin* was to introduce the definition of fraction and English was used to actually express the form definition. The role of *Pidgin* here was used as a pointer to prepare and alert the students of the coming of something important, in this case was the definition of fraction expressed in English. However, English, on the other hand, was given a privileged position in this case and the teacher implied that the final fact they have to learn and recall was the definition of fraction in English. This implied that the definition the students were to recall was that expressed in English.

Generally, the alternated language described in Teacher W's teaching promoted understanding questions and recalled the definition of the term 'fraction'. Similarly it promoted mathematics English through correct pronunciation and spelling of 'fraction' as part of the language of the mathematics register and of general English. But he did not attempt to promote deeper understanding of the mathematics content and mathematical English, which would involve the students in articulating, sharing, discussing, reflecting upon, and refining their understanding of the concept of fraction. Since students were not involved meaningfully, it became teacher-centered teaching. He promoted recall more than understanding. In terms of discourse, Teacher W was very much involved in procedural discourse and did not use the opportunity to pursue any conceptual discourse. Teacher W had the best opportunity to push further to get his students to reflect on the concept of fraction and show deeper understanding of it, but he lacked the teaching skills to utilize the language resource and the skills of code-switching as a teaching tool, to enable conceptual discourse. The first opportunity he had was that when the students told him that they never heard the term 'fraction' before, after he asked a question. He would have extended the conversation by connecting to the realistic context about pork-sharing he presented at the beginning of the lesson. The second time he missed the opportunity was when he asked for the definition of the term 'fraction'. He asked the question in English and repeated the same question in *Pidgin* to help students understand what they were asked for, but he did not give time to the students to respond, nor did he stimulate them to reflect on the definition. Instead, he answered the question himself and told the students the definition of 'fraction'. He did not use the practices of eliciting, an important teaching practice in this situation.

From the descriptions of Teachers K and W's teaching, there were quite distinguishable differences. Teacher K's approaches aimed at introducing the lesson topic and involved students in reflecting on the concept related to the lesson topic, addition. Teacher W, on the other hand, did introduce the lesson topic but aimed to transmit the definition of the lesson topic to the students. The students were required to remember and recall the formal definition in English. Therefore, Teacher K was involved in a conceptual discourse while Teacher W was involved far more in procedural discourse, even though he had the opportunities to extend the conversation into conceptual discourse.

This section showed how Teacher K involved her students in reflecting on definitions of terms by matching known knowledge with the new. The following section presents the second sample of conceptual discourse that Teacher K was involved in. This involved the teacher initiating a conversation that established reasons for certain calculations.

6.4.2 Reasoning Procedures used for Calculation as Part of Conceptual Discourse

This section discusses the second characteristics of conceptual discourse observed in Teacher K's teaching. The discussion highlights how the practices of code-switching and alternating language enhanced conceptual discourse. As indicated earlier, conceptual discourse, according to Setati and Adler (2001), was the discourse in which the reasons for calculating in particular ways and using particular procedures to solve a mathematical problem became explicit topics of conversation. Teacher K was unique because she tried to generate reasons with the students for certain procedures used in calculation. Since there was no other teacher observed engaged in such conversation, there won't be any comparison made in this section with the other seven teachers that participated in this study.

To illustrate, a sample of talk from the content teaching from lesson 1 is presented below as Talk 6. 4. Teacher K started her content-teaching part of lesson 1 in paragraph 69. In the first sentence, she started by saying that they will go into how to add numbers in three digits written in columns. In following sentences in paragraph 69, she was trying to come up with a generalized reasoning that would help students know where to start adding. In the third sentence of paragraph 69 she tried to say that they start adding number starting with the last number to their right. She tried to say it is ‘to the right’, but she recognized a problem in that she was left-handed and her right was left for her students. Therefore, she came up with another idea, which was to identify a stationary location that was due right. Towards the last sentence of paragraph 69, she suggested two locations found at the students’ right; namely Banz a town and *Wahgi*, the biggest river of the *Wahgi* valley. She continued and asked students for a location found at the students’ left in paragraph 71. The students in paragraph 72 responded with Tumba (actually the researcher’s home village). The teacher confirmed this was correct in paragraph 73, but she also suggested some more locations found to their left including the main road and Kopening, a village’s name. In the second sentence of paragraph 73, she summarized the location to the right would be Wahgi and to the left would be Kopening. In the last sentence of paragraph 73, she asked a question related to doing addition, and asked where they should start adding. She asked the students whether they should start doing addition from *Wahgi* towards Kopening (right to left) or from Kopening towards *Wahgi* (left to right). The students responded in paragraph 74 that they will start from *Wahgi* and go up, which indicated towards Kopening which is the left. It literally meant adding from right to left. In paragraph 75, the teacher repeats the student’s response to confirm and congratulates them for giving the correct response. In the second sentence of paragraph 75, she summarizes by saying that this is so (from *Wahgi* and go up) because it is from the right to the left. Her talk was completed by students in paragraph 76 by saying left hand and the teacher confirmed this in paragraph 77. In the rest of paragraph 77, the teacher tried to get the students to say which two digits that were located to the right were to be added first. The three digit numbers were written on the board in columns. In paragraph 78, Pikip successfully identified the two digits as 4 and 9, found in the right-hand columns of the two numbers. In paragraph 79, the teacher tried to say what we do with these two digits. Towards the end, she implied 4 plus something, and the students complete this with 9 in paragraph 80. In paragraph 81, she asked Grace to give the answer to 4 + 9. In paragraph 82, Grace said 13. The teacher in paragraph 83 repeated 13 to confirm this as correct and then asked what she was going to do with number 13, since there were two digits. A student in paragraph 84 said, put down 3 and carry 1. Students were shouting this response so the teacher asked again in paragraph 85, asking Kupul to say it properly for her. Kupul responded in paragraph 86 and indicated again that they will write 3 down and carry 1. In paragraph 87, the teacher asked the important question that required reasoning.

Talk 4. Teacher K's Talk at the Content Teaching in Lesson 1

In Wahgi/Pidgin

69. Tr Okay nau, yumi laik kam long how long wokim plus ya. Yu save pinis tasol mi laik tok gen. Yumi start long, okay mi laik tok olsem, yumi stat long left, eh em rait han bilong mi, mi gat left handed, mi save rait long left han na yupela save rait long em we? Em han kais bilong yu or … nim angek woiro ….okay han tru bilong yu or han tru or we, han, right han bilong yu ah stap long, stap long Banz side or yumi tok Wahgi side ah?
70. Chn yes
71. Tr Na left han bilong yu stap long wanem hap stret?
72. Chn Tumba
73. Tr Tumba or main road ya or yumi tok Koponing. Em left han bilong you stap long Koponing and right hand stap long Wahgi. Okay,olsem na taim yumi laik wokim plus, yumi stat long Waghi igo antap or tumba igo down?
74. Chn Wahgi igo antap
75. Tr Wahgi igo antap, em gutpela tru. Em bicos yu stat right han igo antap long…
76. Chn left han
77. Tr left han. Okay nice, nau yumi bai plusim wanem namba wantaim wanem namba, olsem yumi statim tambelo igo antap ya? Wanpela putim han antap na…. Yes, Carol, ah yu bin tok pinis. Julie, yu tok? Okay, yumi nonap wait, yes yu Pikip?
78. Pikip 4 na 9,
79. Tr. okay yumi tok wanem? 4 plus …
80. Chn 9
81. Tr answa bilong en yu tok, Grace? 4 + 9
82. Chn 13
83. Tr Okay, 13. Nau bai mi wokim wanem long dispela 13, em tupela number ikam so…
84. Chn put down 3 and carry 1 (chn calling out)
85. Tr No shouting,… yes Kupul yu tok, yu tok gut na mi harim.
86. Kupul … yumi raitim 3 na 1 yumi karem igo
87. Tr Bilong wanem yumi raitim 3 igo down long hia?
88. Chn Em stap long Wahgi side
89. Tr Em stap long Wahgi side, em tru ah?
90. Chn yes
91. Tr So, olgeta taim namba ikam long Wahgi side yumi putim igo …
92. Chn first
93. Tr down, igo down hariap na number kam long Tumba side yumi …
94. Chn putim igo antap
95. Tr putim igo antap or narepela yumi tok, 'carry'. … kinim sip ep mine punamin eh. .. em tru ah. Okay, so nau mi putim wanem long hia?
96. Chn 3
97. Tr Ah, Wolum bai tok, yu tok
98. Wolum Put down 3, carry 1.
99. Tr Put down 3 carry 1. .. Bilong wanem mi bai putim 3 down?
100. Chn Ems stap long Wahgi side
101. Tr Ems tap long Wahgi side. Dispela law em yu mas holim stret. 9 + 4 em 13, put down 3, carry 1. Number long apsait long Tumba side em yumi mas carry igo antap olget taim. Nau, Wolum pinisim.

Translation in English

69. Tr. Okay, now we come to learning how to calculate using plus. You already know it but I want to say it again. We start from, okay want to say that, we start from left of our hand, which is my right hand, because I am left handed, I write using my left hand and you which one do you use to write? It I syou right hand or … you right hand. Okay your right hand is at the Banz side or let say Wahgi side ah.
70. Chn Yes
71. Tr Where is your left hand?
72. Chn Tumba (viallge's name)
73. Tr Tumba or main road or let say Kopening. Your left hand is at Kopeneng and right hand is at Wahgi side. Okay, therefor when we want to do plus, do we start from Wahgi and go up or Tumba and come down?
74. Ch Wahgi and go up.
75. Tr. Wahgi an go up. That's very good. This is so because you start from right hand and go to …
76. Chn left hand
77. Tr Left hand. Okay, nice. Now, what number can we plus together, that's we we start from bellow to the top? Can any one put your hand up and … Yes Carol, ah you already responded. Julie, you say it. Okay, we can not wait, yes you Pikip?
78. Pikip 4 and 9.
79. Tr How do we say it? 4 plus …
80. Chn. 9
81. Tr say its answer, Grace ? 4 plus 9.
82. Grace. 13
83. Tr. Okay, 13. Nau bai mi wokim wanem long dispel 13, em tupelo number ikam so..
84. Chn. Put down 3 and carry 1.
85. Tr. No shouting … yes Kupul, you say it. You say it properly for me.
86. Kupul …we write 3 down and carry 1.
87. Tr. Why do we write 3 down here?
88. Chn. It is at the Wahgi side (right hand)
89. Tr. It is at the Wahgi side, is it true?
90. Chn. Yes
91. Tr. So, all the time when the number is at the Wahgi side, we put it …
92. Chn first
93. Tr. Down, put it down first and number at Tumba side (left hand) we…
94. Chn put it on top
95. Tr put it on top or another way we say 'carry'… we bring it over to the top. Is it true? Okay, so now what do we put here?
96. Chn 3.
97. Tr. Ah, wolum will say it, sy it.
98. Wolum Put down 3, carry 1
99. Tr. Put down 3, carry 1. Why would I put down 3 and carry 1.
100. Chn It is at the Wahgi side (right hand)
101. Tr It is at the Wahgi side. This law, you must hold it, 9 + 4 is 13, put down 3, carry 1. Number at the Tumba side (left hand), we must carry to the top all the time. Now, Wolum you complete it.

She asked why we should write 3 down. The students in paragraph 88 told her the reasons that number 3 was found towards the *Wahgi* side. Reflecting on the reasoning discussed earlier, it was addressing the issue of where students should start adding but did not involve reasoning related to how to write the sum in tens form. However, the students applied the general reasoning they had generated before here and indicated that when sums are in tens form, the number to the rights (units) will be written down and number to the left (tens) to be carried over. Students have successfully generalized the rule for a new context. The teacher was very impressed and repeated the response in paragraph 89. The teacher realized that the students were able to use the rule they initiated for a different context and it seemed to be used correctly again. She summarized and reinforced in paragraph 91 that all the time when a number is found at the *Wahgi* side, we write it down. In paragraph 93, she continued and said that the number at the Tumba side, and the students completed her sentence in paragraph 94, that they put it on top. The teacher repeated the students to approve this in paragraph 95 and introduced the formal term ‘carry’. She indicated that the formal way of saying ‘put it on top’ is ‘carry’ and she switched from *Pidgin* to *Wahgi* and repeated the definition of ‘carry’; to take to the top. Towards the end of paragraph 95, the teacher asked what does she put here, and a student responded in paragraph 96 that it was 3. The teacher was not satisfied with this one-digit answer and asked Wolum to say it properly in paragraph 97. Wolum in paragraph 98, said put down 3 and carry 1, using the formal English words, which was probably the response the teacher was expecting. The teacher repeated Wolum’s response to approve it and repeated the questioning that required reasoning in paragraph 99. She asked why we would write 3 down and the students in paragraph 100 indicated that it was so because it was found at the *Wahgi* (right) side. The teacher repeated in paragraph 101 the students’ response to approve and summarized; that we must remember that number found towards the Tumba side will be carried over.

This conversation was entirely in *Pidgin* and the most frequent type of code-switching used was code/phrase borrowing, mostly borrowing mathematics terms, and mostly expressing these in English. The most commonly borrowed words used were ‘right’, ‘left’, ‘plus’, number names such as ‘three’ and ‘nine’, ‘put down’, ‘carry over’ etc. Even though there was no direct code-switching involved to enhance such conversation, the national language, *Pidgin,* was successfully used to generate this conversation that aimed at stimulating students to give reasons for certain procedures they used. Such a conversation would not have been possible if it involved only English as a foreign language. The teacher started by discussing a common direction as part of the reasoning that they all could use. The students were actively involved and they agreed that *Wahgi* would represent right and Tumba would represent left. Such a general rule set at the beginning helped students to give reasons for the procedure of writing down and carrying over. The teacher asked why they should write down and carry over, the students successfully gave the reason that it was so because the digit was found at the *Wahgi* side and carry over because it was at the Tumba side. This may be a simple conversation, but it promoted a skill that was part of establishing mathematical reasoning that developed a procedure they could use in mathematics calculations. Therefore, such a conversation was not only outstanding, but the teaching approach, particularly the questioning technique, stimulated good reasoning responses from the students.

So far in the above two sections, outstanding teaching practices related to code-switching and alternating language that enhance conceptual discourse were examined. It was shown how such a teaching practice stimulated reflection of definitions to help promote deeper understanding of mathematics concepts and mathematical English. In addition, it also involved students in generating reasons for certain procedures of calculation. Such a conversation promoted not only reasoning skills but also involved students in reflecting, discussing and redefining their understanding of the procedures used to calculate. The following section will examine the teaching practices within non-mathematics discourse.

6.5 Unique Practices of Code-Switching Within Non-Mathematics Discourse

It was indicated in Table 6.5 that both discourses, mathematics discourse and non-mathematics discourse, were found in each of the three lesson phases. The general purposes of code-switching and role of alternated languages within mathematics discourse were examined in Chapter 5. Therefore only the outstanding practices within conceptual discourse were examined and compared in the earlier section. However, this did not include practices that were found within non-mathematics discourse.

The type of code-switching that mainly will be considered here is inter-sentential switching. Table 6.7 shows the ways of talking involved after inter-sentential switching within both mathematics discourse and non-mathematics discourse. Ways of talking within mathematics discourse were shown already in Chapter 5, but they are presented again on Table 6.7 to help compare what ways of talking were involved within non-mathematics discourse.

Table 6.7. Teaching behavior related to Teacher K's Switching Language.

Discourse	Characteristics of Switching
Mathematics Discourse	• Questioning • Explaining • Repeating; Questions. Explanations, Students response
Non-Mathematics Discourse	• Questioning • Instruction • Repeating; Instructions

An analysis of Table 6.7 shows that three ways of talking were observed in this study: questioning, instruction and repeating instructions. This was similar to the three ways of talking found in mathematics discourse: questioning, explaining and repeating. The focus of this Chapter does not permit a detail representative description of practices from all 16 lessons within non-mathematics discourse. These examples were examined to find some outstanding teaching practices related to code-switching. It turned out again that Teacher K was such a teacher, and so her teaching practices within some examples of non-mathematics discourse will be examined. The discussion will examine each of the general ways of talking identified in Table 6.7.

6.5.1 Questioning within Non-Mathematics Discourse

This section describes practices of code-switching and alternating language used for questioning as part of non-mathematics discourse. Table 6.8 shows the descriptions of questions asked both within mathematics discourse and non-mathematical discourse in the three lessons taught by Teacher K. Such presentation sought not only to compare roles between each discourse, but even more to differentiate those related to non-mathematics discourse.

Table 6.8, shows that questioning was mainly observed as a part of regulatory discourse within non-mathematics discourse in the teaching of Teacher K. The alternated language was mostly in one of the local languages, *Pidgin.* As indicated in Chapter 5, and also shown on Table 6.8, questioning within mathematics discourse was mainly done for eliciting purposes. But in this case, questions asked within non-mathematics discourse were not for eliciting. They were used for regulating both mental and physical behavior. The questions asked to regulate mental behavior were those which directed students mentally, in most cases to steer the flow of the lesson. This could involve the teacher making students aware of what will happen next to guide students through the lesson. Similarly, the questions asked to regulate physical behavior were those aimed at managing students' conduct for the success of the lesson.

Table 6.8. Questioning within Non-Mathematics Discourse by Teacher K

Discourse		**Reason**	**Language Switching**	
			From	**Used**
Mathematics Discourse	**Procedural**	Asking students what they would do when number reaches a thousand.	English	Pidgin
		Asking students what they should do when the sum of two numbers reached 13.	English	Pidgin
		Asking for the number of centimeters and meters in meters and kilometers.(code-mixing)	-Pidgin/English/Wahgi	
		Asking for the sum of two numbers they were working out earlier.	Pidgin	English
		Asking for the number of groups made in 2s from 16 stones.	Pidgin	English
	Conceptual	Asking students to give definition of addition in Wahgi.	English	Pidgin
		Asking students why they should write down a number and carry the other.	English	Pidgin
Non-Mathematics Discourse	**Regulatory**	Asking if they had done similar task before.	Pidgin	English
		Asking if student had a ruler	Pidgin	English
		Asking if they had completed tasks.	English	Pidgin
	Contextual			

The role of the alternated languages in this situation was also obvious. It was obvious that a question required students to understand what was asked in the local language. Questions that demanded recognition of the authority of the teacher were asked in English. Since English was the frequently used language in regulatory discourse, the researcher begins a specific analysis with a conversation that involved English to ask questions. To illustrate, Talk 6.5 presents such an example.

Talk 6.5. Asking Questions in Teacher K's talk within Non-Mathematics Discourse in Lesson 1.

In Pidgin/English	**English Translation**
149 (c)Tr. Plus em stap antap ya, yu supim plus ikam down long wanem? Em ya, olgeta yu wokim plus antap ya. Wokim plus antap, workim gut na mekim.	Tr. (c) Plus is up there, why are you putting it down here? All these ones, you got them up there. Put plus up there and do it properly.
149 (d) Tr. Kenny, do you have a ruler? Kenny, you have a ruler**?** … Yu no raitim stret. Stap long em, aninit stret 9 bai istap. Em ino kam long stret lain ya. Ating yu wokim lain na rait gen.	(d). Kenny, do you have a ruler? Kenny, you have a ruler? … You are not writing properly. Where it is, under it, number 9 will be written. It is not in the straight line. I think you do the line and write it again.

The conversation before the question in paragraph 149 (c) was about writing the plus sign properly as part of content teaching part of the lesson, and could be categorized as mathematics discourse. Then Teacher K switched in paragraph 149 (d) to English to ask if the student had a ruler, which is part of the lesson's non-mathematics discourse. The question aimed at regulating a physical behavior, where the student (Kenny) will have to show his ruler. Teacher K indicated that the student should use his/her ruler to help write the numbers and signs in order neatly. To take a firm and authoritative position for something she realized was a serious issue affecting the neatness of the students' work, she switched and used English to play this role to convey the message effectively. The role of English used through the process of code-switching in this case was not only to expose students to general English, but help the teacher take an authoritative place in the class.

Using the local language was not common in non-mathematics discourse, but it sometimes was used with the important role in helping students understand a request. To illustrate, Talk 6.6 shows a question asked by Teacher K in *Pidgin*.

Talk 6.6. Questioning in Teacher K's Talk with Non-Mathematics Discourse in Lesson 3

Pidgin/English	**Translation**
58. Tr (a) Yeh, yupela bai rait long buk now…. Take out your books, write today's date… Buk blong yu stap or nogat ? Yu tingting plenti istap.	58. Tr . (a). Yeh, you will write in your books now … Take out your books, write today's date … Where is your book? You are not sure and thinking!

In paragraph 58 of Talk 6.6, the teacher started by saying that they will write in their books in *Pidgin*. In the next sentence, the teacher switched to English and requested students to take out their books and write dates. This was an instruction in a request form. But in the next sentence, the teacher switched and asked a question in *Pidgin*. She asked; '*Buk blong yu stap or nogat* ?' (Where is your book?). The teacher switched from English to Pidgin to ask a student where his/her book was. She completed that paragraph in *Pidgin* with a comment that the student was wondering in thoughts. Since this section is about questioning and regulating behavior, the researcher reflects on the question asked. The purpose of the question was to regulate both mental and physical behavior, when asking where the student's book was. Initially, the question would regulate mental behavior, when the students could be required to remember where his/her book was. Then, the next thing this question could do was regulate some physical behavior and these could include telling the teacher where the book was or moving to get the book from where it was in the classroom if that student was able to remember. The chosen alternate language in this question was *Pidgin*. The role of the language was used not only to ask the question, but also to help students understand what they were asked for in the language they spoke fluently, so that they could remember, explain and or act accordingly, in this case to remember and find the book which was missing. Furthermore, asking a question in their local language was friendlier and the teacher did not take up an authoritative position, but felt closer to the students than if she had asked a similar question in English.

In summary, the purpose of code-switching and role of the local language and English alternated was to help students understand questions aimed at regulating both mental and physical behavior and promote general mathematical English. What was not part of the focus in this Chapter was that using local language made the conversation friendlier and using English made teacher take up an authoritative position indicating the urgency and importance of the content of the conversation.

This section described the role of *Pidgin* and English used as an alternate language to ask questions through code-switching as part of non-mathematics discourse. The following section presents the role of alternate language used through code-switching to give instructions within non-mathematics discourse.

6.5.2 Instructing within Non-Mathematics Discourse

The next characteristic of talking examined within Teacher K's teaching was related to giving instructions. In some ways, this way of talking was similar to questioning as described earlier, except that the statement requesting students to do something was not in a direct question form, but was rather a statement of request. Table 6.9 presents the description of the sentences that were constructed after switching that provided instructions for the students to follow, within the three lessons taught by Teacher K.

Table 6.9. Instructing within Non-Mathematical Discourse by Teacher K.

Instructions	**Purpose/Language**	
	Content Teaching	**Content Practice**
Behavior helping to practice procedures (Procedural Discourse)		Requesting students to; • use stones to help attempt the task.(*Pidgin*) • write numbers in column (code-mixing). (*Pidgin*/English/*Wahgi*) • count stones in 10s. (English) • just look at it and give a guess answer. (English) • put stones where it marks 1 meter (code-mixing) – (English/*Pidgin*)
Controlling behavior for classroom management (Non-mathematics Discourse)	• Requesting students to look up front towards the blackboard.(English) • Requesting everybody to watch what she was doing. (English) • Requesting students not to shout out answers. (English)	• Requesting students to hurry, be fast and do tasks quickly. (English) • Requesting students to do a certain task. (Code-mixing) • Requesting students not to do the revision task. (English) • Requesting students to write in different pen colors for numbers and letters. (Code-mixing).(English/*Pidgin*) • Requesting a student to compare neatness with a friend to improve. (Code-mixing). (*Pidgin*/English) • Asking students to take out their books and write dates. (English)

Table 6.9 shows that code-switching was used to give instructions as part of regulatory discourse. These sentences have been divided into two categories of regulatory discourse. The first was related to procedural discourse, where instructions were given that helped guide students in their practice of calculation procedures taught in the content teaching. This occurred mainly within content practice, when students were attempting a set task to practice the procedures already taught during content teaching. This was the case because most

talking during the content teaching phase involved the teacher explaining the content and involved less of the students' verbal participation. The second category was instructions simply aimed at controlling the behavior of the students for classroom management purposes. Such instructions were found in both parts of the body of the lesson; content teaching and content practice. Since the first purpose of giving instructions was part of the mathematics discourse and indirectly highlighted in Chapter 5, the details will not be examined in this section. However, as it was the focus of this section, the instructions aimed at controlling behavior for classroom management will be discussed in detail in this section.

As shown in Table 6.9, Teacher K gave instructions that aimed at managing behavior in both content teaching and content practice. Such instructions during the content teaching included requesting students to look up towards the board and watch what she was doing up at the front, and requesting students not to shout answers when a question was asked. Such instruction regulated physical behavior and did not contribute to practicing the skills taught as part of mathematics content. Similarly, such instruction was also part of the content practice phase of the lesson. The instructions given in this part of the lesson discourse included requesting students to be quick and fast in doing the task, asking students to do a certain part of the set task and not to repeat revision tasks, requesting students to write in different pen colors for numbers and letters, asking a student to compare the neatness of his book with a friend and to improve, and asking students to take out their books and write dates. For most of these instructions, Teacher K switched and used English. Talk 6.7 illustrates instructions in English related to managing behavior within the body (content teaching and content practice) of the lesson:

Talk 6.7 Giving Instructions by Teacher K in Content practice in Lesson 2.

Pidgin/English	English Translation
137. Tr Nau em next person, okay start nau. … **And every one of you, watch**… one meter ruler em… how many centimeters… yumi countim?	137. Tr. Now, it will be next person, okay start now…and every one of you, watch..one meter is … how many centimeters … let's count them.
138. Chn 100	138. Chn. 100

Talk 6.7 was part of a conversation that was taking place within the content practice phase of lesson 2 and the lesson topic was measurement. As part of content practice phase, the teacher

asked students to go outside and measure the distance between the school gate and church. It was within this conversation that an instruction was given purposefully to manage the general behavior of the students. From Talk 6.7, in the first sentence of paragraph 137, Teacher K asked a student to use a meter ruler and start measuring. This was followed by the instruction that is the focus of this discussion. The teacher instructed the rest of the students to watch as a student measured the distance using the meter ruler. The teacher continued the talk in the same paragraph to ask for the number of centimeters found in a meter ruler. The leading language in paragraph 137 was *Pidgin*, but Teacher K switched to English purposefully to give instructions. The role of English in this part of the talk was not only to promote general English, but also as a language of authority to give firmer instructions aimed at managing behavior of the students when they were outside the classroom.

So far the researcher has described the purpose of switching related to instruction. The third purpose of switching was related to repeating, but specifically repeating instructions which was part of non-mathematics discourse. This purpose is discussed in the following section.

6.5.3 Switching Languages to Repeat Instructions within Non-Mathematical Discourse

The third way of talking after switching a language was to repeat instructions. Table 6.8 describes how Teacher K repeated instructions within non-mathematics discourse.

Table 6.10. Reasons for Switching Language to Repeat Instructions.

Discourse		**Repeating Instructions/Language used**	
		Reasons	**Language Used**
Non-Mathematics Discourse	**Regulatory Discourse**	- Asking students to rewrite. (code-mixing)	*Pidgin/Wahgi*
		- Asking students to put stones on the desk.	*Pidgin*
		- Asking students for their attention.	English
		- Asking students to put stones together.	English

As indicated earlier, Teacher K switched language to give instructions mainly to regulate behavior. The language frequently used for this purpose was English, but Table 6.10 shows that the other two languages were used when repeating instructions. It was indicated earlier that, depending on where the instruction was given in terms of lesson phase, it was apparent that the instruction could be part of mathematics discourse or non-mathematics discourse. This meant that the teacher repeated instructions as a means to reinforce each instruction so as to regulate behavior that would both directly (when teaching the content) and indirectly (when not teaching the content) benefit the success of teaching and learning. Table 6.10 shows the reasons for the purposeful switching and repeating of instructions as observed in this study. The reasons observed included repeating instructions that asked students to rewrite, to put stones on the desk, requesting students' attention, and to put stones on the table. These repeated instructions were related to regulating behavior. There were at least two things going on here: these instructions were part of talk that was teaching mathematics content and, hence, mathematics discourse, but they were also part of classroom-management and hence non-mathematics discourse.

From Table 6.10, it is seen that all three languages were used to repeat instructions. It was observed through this study that there were distinct roles of each language, specifically for the local languages compared to English, while repeating instructions. As indicated earlier, repeating instructions in the local languages, *Wahgi* and *Pidgin*, was to help students understand what was expected of them so they would in turn be able to respond accordingly. On the other hand, instructions repeated in English, apart from giving students access to English, were used also to express firmness, and to reinforce and emphasize the importance of what the students were expected to do. To illustrate, Talk 6.8 is provided as an example.

Talk 6.8. Repeating Instructions in Teacher K's Talk within Non-Mathematics Discourse in Lesson 1

Pidgin/Wahgi	**Translation**
155. Tr. (c). Rewrite please…raitim gen …. ala bok…. Raitim gut. Plus ino stap, putim plus long hia, Mariam.	Rewrite please…. Raitim gen … ala bok … write it properly. There is no plus. Put your plus in here. Mariam.

Talk 6.8 is part of a conversation that repeated an instruction in all three languages as part of non-mathematics discourse. Teacher K asked a student to rewrite something. She begins the instruction in English, switched to *Pidgin* and then to *Wahgi* before she returns to *Pidgin*. It

seems that a student was not writing the number sentence he had to add; he did not put the digits and signs in their proper order. To emphasize, she used all the three languages. Initially, she used English to take an authoritative position and emphasis the seriousness of her concern that the student was not writing properly. To help the student understand and feel friendlier in the request, the teacher switched and used both local languages; first in *Pidgin* and then in *Wahgi*. Such practices of code-switching and using alternated language aimed at promoting understanding of the instructions to be followed accurately and promote general English. The added role, which is not part of the focus of this chapter, was using local language to get closure with the students and using English to take up authority position and also emphasizing the concern in focus.

So far, the purpose of code-switching and the role of alternate languages used to promote understanding, mathematical English and general English, both in mathematics discourse and non-mathematics discourse, were examined. This examination was based on the teaching and linguistic behavior observed in teaching, particularly that of Teacher K. This study also conducted interviews with Teacher K to understand her perspective on the purpose of code-switching and the role of the alternated languages; in this case both the local languages (*Wahgi* and *Pidgin*) and English. This interview aimed to investigate if the practices of code-switching and alternating language were deliberate acts to promote understanding and both mathematical and general English. The results from this interview are presented in the following section.

6.6 Results from Teacher K's Interview

The linguistic behavior through teaching described in the earlier sections from Teacher K matched very much her perspectives identified through the interview. As part of this study, semi-structured interviews (see section 4.4.2) were carried out straight after her teaching lessons, and these were recorded on video. The interviews began with a few set questions, but more questions were generated as the conversation progressed. Teacher K indicated in the interviews that she used three languages in her teaching, *Wahgi* (*tok ples*), *Pidgin* and English. When she was asked why she switched back and forward between these three languages, she responded as follows:

> Okay, that is because, frankly speaking, I would say that, ah I would like to speak Pidgin and 'tok ples', at times where things go hard, I use 'tok ples' and I would say that I am not interested in speaking 'tok ples' but at times I use and for the other two kids that are with us, from different province, I use Pidgin most of the time and I am used to speaking this Pidgin all the time.

In the conversation presented above, she clearly indicated that she was not interested in using *Wahgi* ('*tok ples'* as she called it) or *Pidgin*, but she did at times when things got harder. She was referring to the times when she realized that what she was teaching became difficult for students to understand, she would switch and use the two local languages. She claimed in the same paragraph that she used *Wahgi* for the understanding of the majority of the local students and *Pidgin*, the national language for students who were not locals, but from other provinces of Papua New Guinea. The response she gave is presented in the following paragraph:

> Because, ……., we believe that in years to come, when our kids, grade 3 students as they go up the ladder (grades), and as we have observed, they are not really speaking good English. So we are trying our best to speak English and Pidgin is our common language so, that is why I am speaking most of the time Pidgin and English to help them speak better English later, because in Elementary they just come with 'tok ples' (Wahgi) and in their own vernacular and they come out with this language and it's very hard for us to explain a sentence in English, it's very hard for them to understand. That's why I myself I speak English all the time and at times I try to get hard lesson across, I speak Pidgin.

Teacher K was trying to say that students at the primary school starting with grade 3 were not speaking good English. She also indicated that she used English most of the time in her teaching. But, since the students came from elementary school where the language of instruction was the local language, *Wahgi*, she found out that it was difficult for her students to understand her talk in English. It was obvious through this conversation that she used the local languages for understanding purposes, but she did not give any reasons why she decided to use English and discouraged herself from using the local languages. The researcher asked her why she wanted to use English and wanted her students to learn English. The following paragraph presents what she said was her reason:

> Well, I myself I would say that I really like English because, when, I was taught with English with white people and I'm used to English and I want my kids to speak English, in years to come, later on. And that's why, but then reform has come in with another way of teaching and that's really, we are confusing ourselves.

What Teacher K says here was that she wanted to use English more and wished that her students learnt English as early as grade 3. According to her, it was important because

English was the language her students expected to learn to speak fluently for the upper primary and secondary education, and even for future employment. The researcher went further to ask what were some of the benefits of using the local language. Teacher K again indicated that the local languages benefited teaching and learning but insisted that she highly favored English. Her response is presented in the following paragraph:

> That's exactly; they feel free to talk to us. And they feel free to talk to us in Pidgin and their own 'tok ples'. Just as freely as a family talk to a parent. And that is good, we like it too. But, then we would like our children to speak English and that is what our heart wants.

Teacher K indicated that students felt free to communicate and express themselves openly when the local languages were used. She explained that the way they talked to her was like talking at their home with their family members. She was also indicating that this was different when English was compulsory. She stated above that this was very good, but still, she emphasized that from her heart, she wanted her students to speak English. This was what Setati and Adler (2005) regarded as the tension between using English and using the local languages. The researcher regards this as a positive tension because it kept the language use in balance, promoting English and understanding through the use of the local language. Due to this tension, from the results presented earlier, it was obvious through her teaching that she carefully calculated and used the languages effectively to respond to this tension. She used the local languages; *Pidgin* and *Wahgi* to promote understanding within lesson parts and discourse that involved teaching mathematics content. This was made possible by using the local languages as verb phrases to construct the sentences. In addition, she tried to promote English in the lesson parts and discourse that did not involve teaching mathematics content. In addition, in the conversation that taught mathematics content, mathematical English terms/phrases were used as noun phrases, occupying a privileged part of the sentence being promoted by the local language used as verb phrases. With this, the linguistic behavior in Teacher K's teaching matched her perspectives related to the role of the local languages and English. Therefore, such positive teaching behavior was promoted due to the tension existed as part of Teacher K's perspective relating to alternating the local language and English through code-switching within both mathematics discourse and non-mathematics discourse.

6.7 Summary

The focus of this Chapter was to understand the teachers', but mainly Teacher K's, intended role of alternated language through the practice of code-switching within mathematics teaching in a multilingual classroom. This study collected results from two data source; first from her interview and second through linguistic behavior observed while the teachers were teaching mathematics. The results from interviewing Teacher K showed that there existed a tension in terms of using language in a multilingual classroom. The tension was created by her desire/perspectives about using language to promote understanding and to promote English, both mathematical and general English. She indicated that she wanted her student to understand the important mathematics concepts and related mathematical English through appropriate practices of code-switching by using the fluently spoken local languages (*Wahgi & Pidgin*). On the other hand, she also wanted her students to be exposed to English, both to access the language in general and to learn mathematical English. She thought that her students needed English for future employment and having access to English as early as grade 3 was important. Such a perspective about language use not only created the tension, but influenced the way Teacher K utilized the language skills of code-switching and alternating language as a powerful teaching tool.

She showed that a variety of languages could be used in responding to the linguistic need of the lesson. To illustrate, she used three types of language-emphases to promote different roles as the lesson context demanded. The first involved single language emphasis and this involved two categories; the common category used more local language promoting understanding and the less common category was where English was emphasized promoting both mathematical and general English. Such language emphasis was recommended for elementary education, but teachers in Grade 3 show the need for such language-use. The second type of language-use was similar to what was recommended for grade 3, where teachers used close to 60% of local language and 40% of English. Such language-use aimed to promote understanding, mathematical English and general English simultaneously. The third type of language use observed was that recommended at the policy level for grade 4, where close to 50% of local language and 50% of English were used. Such language-use also aimed at promoting understanding, mathematical English and general English. The fourth language-use observed was that recommended for grade 5, where close to 70% English used and 30% of local language used. Such language use placed greater emphasis on English, but it had potential to promote understanding, mathematical English and general English simultaneously.

The roles of alternate language-use for teaching were examined within three contexts; within different lesson phases, within each discourse, and within different ways of talking. In other words, the role of the chosen alternate language was studied within the different ways of talking for each discourse found in each lesson phase. The data showed that Teacher K used effective practices of code-switching and language-alteration within conceptual discourse of mathematics discourse. Specifically, she involved students in reflection and asked students to give reasons for procedural calculation. Such ways of talking presumably promoted in the students a deeper understanding of both mathematical concepts, mathematical English, and general English. Furthermore, she probably promoted understanding, questioning and instructions and general English as part of non-mathematics discourse by emphasizing the use of English. With such results, the unique practices of code-switching and language alteration, generally aimed at promoting understanding and English, both mathematical and general English, but with different emphasis responding to linguistic needs to the lesson. However, a collective emphasis should promote the three roles; understanding, mathematics English and general English. Such achievement is directly in line with the aims and goals of the new language policy of Papua New Guinea.

7.1 Introduction

This chapter will discuss the results presented in Chapters 5 and 6 and, when appropriate, link these results to the literature reviewed in Chapters 2 and 3.

The literature reviewed in Chapter 2 noted that the teaching process plays an important role in guiding students' learning (Mercer, 1995). According to Vygotsky (1978), what should be aimed for is that a teacher represents the 'more knowledgeable others' (MKO), and, through the teaching process, the teacher provides the needed guidance at the 'zone of proximal development' (ZPD), which effectively guides learning. However, at the centre of this relationship between teaching and learning is communication. For the teaching process to gain its proper place in learning, it depends on how the teaching process is effectively communicated by the teacher, aiming to guide successful learning. Among others, the most common medium of communication, and the one highlighted through this thesis, is language. As Vygotsky (1962) argued, learners use language to negotiate their understanding with the teacher. Language is vitally important for children to communicate with adults or peers who are more knowledgeable others (MKOs), and who can play a critical role in guiding and modeling the correct ways of expressing information and knowledge, which learners internalize. Mercer (1995) extended this view to suggest that, in a classroom, appropriate ways of talking, suitable for classroom practice, enable effective communication within the teaching process, and it is this that so often guides students' knowledge-construction that results in successful learning. Such a view of language is not straightforward in a monolingual context, becoming far more complex when more than one language is involved.

Cummins (1985), drawing on his bilingual theory, gave some hints that students who are balanced bilinguals or balanced multilinguals have a better chance of establishing positive cognition processes when teachers use the students' languages during the teaching process to guide their learning. However, some classrooms in the world are forced by government policy to have a language context that makes the students unbalanced multilingual learners. This was the case in this study where students, fluent in their own local languages, were learning English as an additional language, although at the same time it was being used as the language of teaching mathematics. The government of Papua New Guinea officially recognized in the mid 1990s this language context, and it associated learning challenges, by recommending that the fluently spoken local languages would be used as a resource to teach English. This included the case of teaching mathematical English and the related content. This way of using language was described in the new language policy as a ‘bridging process’ (*Mathematics - Lower Primary Syllabus*, 2004).

When one language is used as a resource to introduce the other, the language practice of code-switching cannot be avoided. With the new education policy, it was possible to explore the use of code-switching as an explicit teaching/learning strategy in PNG classrooms. According to Skiba (1997), this language practice not only involves a language shift, but it also reflects the skills of a multilingual in selecting a language purposefully to enhance effective communication. With this, an effective communication process through teaching within a bilingual or multilingual classroom involves three things: more than one language, skills of code-switching enabling purposeful use of each language, and an effective way of talking that uses code-switching to move to an alternate more suitable language, when deemed necessary This study aimed to understand the purposes of teachers in using code-switching, and in particular to determine the role of the local languages in this practice when teaching mathematics in PNG classrooms. It was conjectured that this was an alternate way of talking as part of normal verbal communication between multilingual speakers, and that within the teaching process this practice might more effectively guide learning. To gain deeper insights into this issue, this study was guided by four major research question as posed in Chapter 1 and 4, but listed here for convenience. These questions will be used to frame this discussion chapter, and an attempt to answer each will be undertaken. The four research questions were

- What were the language context and practices found in grade 3 mathematics classes?
- What were the purposes of code-switching within mathematics teaching?
- What were teachers’ perspectives for using the local languages and English in teaching?
- What were the roles of the local languages in teaching?

As indicated in Chapter 4, these questions were used to guide a multiple-case study. Specifically, eight teachers were selected as cases. These teachers were chosen because they taught within the linguistic boundaries of *Wahgi* and at least used the local language (*Wahgi*) and English in their teaching. This study observed 16 lessons from these teachers that used such a language context. They taught different mathematics topics related to Number, Measurement and Geometry (see details in Appendix C: 5.5). Within this teaching process, this study targeted the role of the local languages alternated through code-switching as a resource to introduce mathematical English and mathematical content. However, the question related to this focus will be addressed in the final section of this chapter. Addressing the other three questions first, which deal with distinguishing the language-context that might have promoted code-switching and investigating the purposes of teachers for using this language-practice in their teaching, gives useful background to the fourth and key question. Therefore, in section 7.2, the results related to the question about language context and how the language practices of code-switching get to be used in teaching are discussed. In sections 7.3 and 7.4, the results related to the purpose of code-switching are discussed. In the first of these sections (7.3), results from observing language use within teaching practices are discussed and, in the latter section (7.4), the teachers' perspectives related to the purpose of alternating languages through code-switching are discussed. These discussions briefly highlight the role of the local languages, but since the use of the local languages was the major target of this study, their roles are described in more detail in section 7.5.

To begin, the following section (7.2) addresses the first question related to the language context and practices within grade 3 mathematics classrooms.

7.2. What were the language contexts and practices found in grade 3 mathematics classes?

As indicated earlier, the major target of this study was to distinguish the role of local languages within a multilingual teaching environment when mathematics was taught. This officially recognized multilingual language context came about with a change in the language policy for teaching and learning in Papua New Guinea. The new language policy of Papua New Guinea recommended that, in the lower primary schools, teachers should use the local languages as a teaching resource to introduce English in all schooling subjects, including mathematics (*Mathematics - Lower Primary Syllabus*, 2004). The policy assumed a bilingual language context, but this study found that it was multilingual. The policy recommended that a local language and English (bilingual context) be used in rural bottom-up primary schools (see Chapter 3 for definitions). To partly assess this policy, this study chose four rural bottom-up primary schools within linguistic boundaries of South *Wahgi* dialect. This study found that instead of two languages, teachers used three languages in the study schools: two local languages, *Pidgin* a national language, and *Wahgi* the local language of Wahgi culture; and English for teaching purposes. The policy recommended that the local language should be used as a resource to introduce English in the lower primary sector of schooling because of the fluency of students in the languages used for teaching purposes. The fluency of grade 3 students in this study related to three rather than two languages. The students were unbalanced from a language perspective, as described by Cummins (1985). The grade 3 students of this study were in an additive stage. That is, they were learning English as an additional language, building on the fluently spoken local languages, *Wahgi* and *Pidgin*.

As noted earlier, to ease these language challenges, the new policy recommended the use of the local language as a resource to help students learn English. In this study of particular interest was how the teachers went about teaching mathematical English. Since each of the three languages was possibly used for different purposes within teaching, it was useful to investigate the frequency of use of each language within each lesson observed as part of this study. These results were used to compare the frequency with which each language was used during the teaching process. The results from this study showed teachers on the whole used a strategy of complementary language use, but with more use of the local languages than of English. Of the two local languages, *Pidgin*, the national language, was used more frequently than the local language, *Wahgi*.

Since three languages were used in most lessons, and at least two in all lessons observed, the natural language practice of code-switching was undertaken by the teachers. They used two types of code-switching: the intra-sentential switching (occurring within a sentence) and inter-sentential switching (occurring across a sentence or group of sentences). The intra-sentential switching involved two types of code-switching: code-borrowing and code-mixing.

The process of code-borrowing involved a term or phrase borrowed from one language and used in a sentence constructed in another language. The common practice observed in this study was that words from the English mathematics register were borrowed and used in sentences constructed in the local languages. The process of code-mixing involved a sentence being started in one language and completed in another language. The common pattern of code-mixing observed in this study was that a local language was used to start most sentences and English was used to complete the sentences. The most frequent type of code-switching was intra-sentential switching. To be specific, this was normally when a term or phrase from the mathematics registers in English was embedded in a sentence constructed in a local language.

To show that these language practices (code-switching and alternating languages) were used for teaching, the frequency of code-switching was recorded (see Appendix C: 5.4). The frequency was used also to distinguish the common language-pairing. This study observed that the most common pairing was between *Pidgin* and English. The practice of code-switching and the common language-pairing were used to serve specific purposes of discourse by the teachers within mathematics lessons. This study found that these language practices were used by the teachers to teach mathematics concepts, and hence they were found within the mathematics discourse of the lessons observed. Interestingly these practices were also used to help promote and regulate proper student behavior, which in turn encouraged the success of mathematics teaching. Thus it was no surprise to find that they were also present as part of the non-mathematics discourse used by teachers in these classrooms.

Turning now specifically to the research question: the language context in the grade 3 classes observed in this study was multilingual, and not bilingual, as the new Government language policy presupposed. The three languages the teachers used within their teaching were *Wahgi, Pidgin* and English, with the local languages used more frequently than English. This encouraged the natural language practice of code-switching. The most popular type of code-switching was code-borrowing. The commonly paired languages during code-switching were *Pidgin* and English. This practice, using the same paired languages, was found in both mathematics discourse and non-mathematics discourse during mathematics classes.

The following section presents results related to the purpose of code-switching observed within the teaching process as part of both mathematics discourse and non-mathematics discourse. The perspectives of teachers related to the purpose of code-switching that might have influenced the teacher to use this language practice within the teaching process will be addressed in section 7.4.

7.3. What were the purposes of code-switching within mathematics teaching?

As indicated earlier, the major focus of this study was to determine the way teachers used the local languages when they were teaching mathematics at the grade 3 level. To determine the role of the local languages, the teachers' purposes in using code-switching, as well as the use made of each language within mathematics teaching, had to be determined. This section aims to present what was found as results for the question that asked about the purposes of code-switching within mathematics teaching. Figure 7.1 provides a summary of this discussion.

Using Figure 7.1, the following discussion aims to highlight the purpose of code-switching, and eventually identify the role of the local languages by examining teachers' ways of talking within the teaching process. Specifically, the discussion will examine meanings of the sentence(s) constructed in the three languages through different types of code-switching within the two discourses: mathematics discourse and non-mathematics discourse (see Figure 7.1).

As indicated earlier, this study examined two types of code-switching within mathematics discourse: intra-sentential and inter-sentential. However, only the latter was examined within non-mathematics discourse to determine the purpose of such language practices given the limited space with the thesis. To determine the purpose of intra-sentential switching, this study examined how a sentence was constructed. Code-borrowing and code-mixing took place within each sentence. In terms of code-borrowing, the terms/phrases borrowed were mainly from the English mathematics register and were mainly used within a noun phrase. The verb phrase of the same sentence was composed using the local languages. As Skiba

(1997) described, the job of the verb phrase in a sentence structure is to promote the noun phrase. Similarly, within code-mixing found in the present study, one of the local languages was always used first for introduction purposes. The teacher then switched into English within the same sentence to present the formal expression related to mathematics, such as a definition.

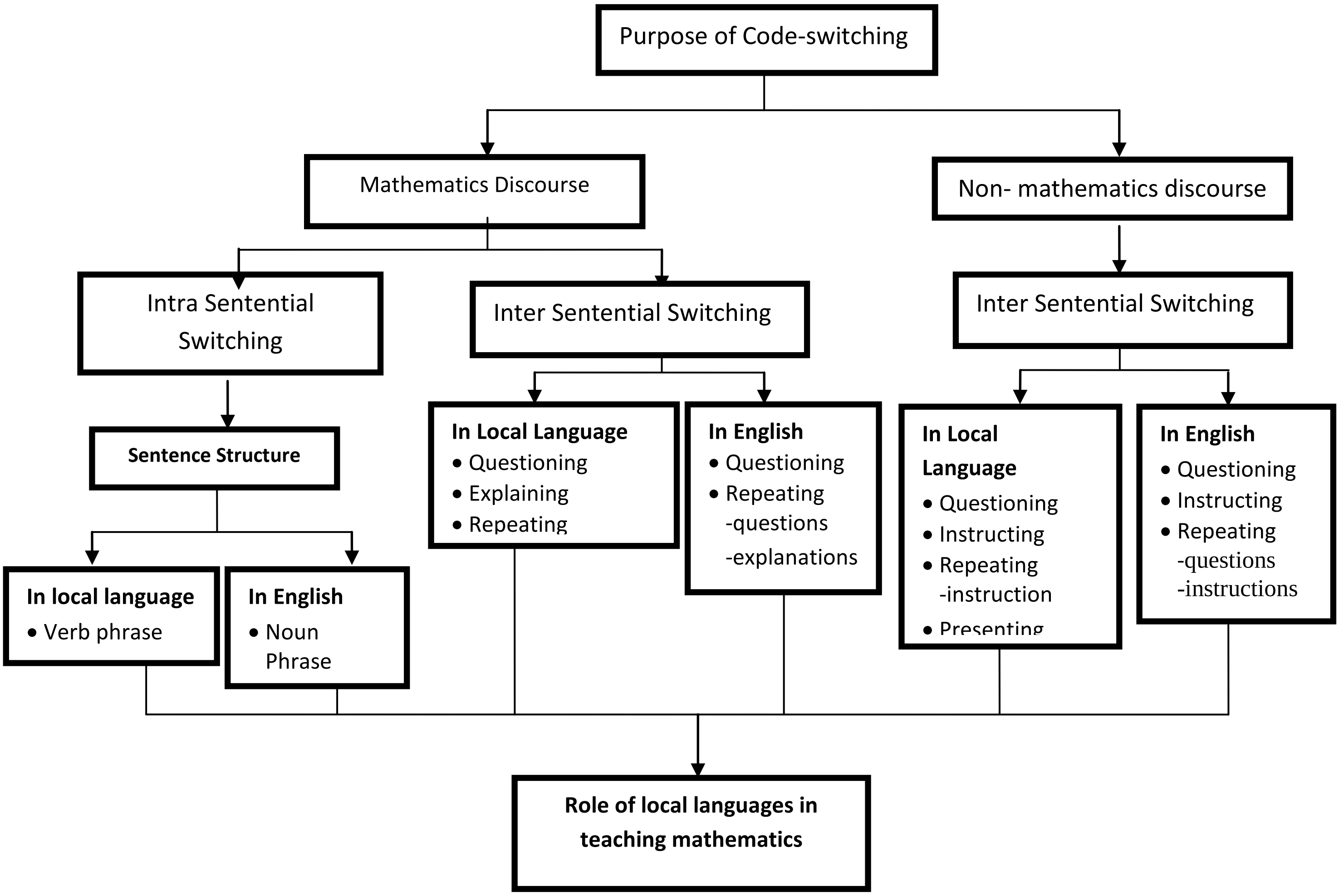

Figure 7.1. Flow chart showing the purpose of code-switching

Both types of intra-sentential switching were commonly observed in sentences constructed to ask questions, to give explanations or definitions. When a question was asked, it was normally about the mathematics register, and invariably was constructed as a noun phrase. In most cases the question was asking for the definition or explanation of the words from the English mathematics registers which had been embedded within the sentence. These questions were also part of eliciting purposes, which will be discussed later. A similar pattern was observed when the teacher asked for an explanation. Similarly, when a definition was given by the teacher, the sentence was constructed using one of the local languages with borrowing from the English mathematics register. The language practice of borrowing using a term from the mathematics register expressed in English, and constructing this as a noun phrase within a sentence constructed in the local language, was a frequent practice, more so than code-mixing or inter-sentential switching. These will be discussed in the following paragraphs. The aim of these sentence-constructions using intra-sentential switching indicated that the local languages were used as a resource to guide the learning of mathematical English and the related mathematical content.

The other type of code-switching this study examined within mathematics discourse was described as inter-sentential switching. This type of code-switching involved a language shift between completed sentences. It appeared that the overall aim of shifting languages between completed sentences was, again, to guide effective learning. This shifting between languages may be comprehended by Mercer's (1995) term "ways of talking". It was noted in Chapter 2 that Mercer outlined various ways in which the teacher might verbally present material in the classroom to guide students' learning. Mercer's suitable techniques of talking included questioning, explaining and repeating. In this study it has been shown that the teachers certainly used questioning, explaining and repeating as Mercer suggested, but these teaching techniques were embedded in a multilingual context. Hence, as has been shown in Chapters 5 and 6, teachers nuanced their questioning, explaining and repeating, using code-switching, and, in particular, shifting between languages at the end of sentences.

Briefly, when examining teachers' verbal communication that involved questioning, it became apparent that it was mainly for purposes of eliciting, another term used by Mercer (1995). As indicated in Chapter 2, eliciting involved teachers asking students about something that they already knew, but checking if the students shared with the teacher the same information and understanding of the concept in focus. What was unique about eliciting in this study was that the teachers used the language practices of code-switching and alternated the local language to ask questions as part of eliciting. This study did not target how its impact on students in their learning, but the teachers thought that this process would help their students' understanding. From the results of this study it appeared that, due to the language shift, the students were comfortable in responding, and it seemed to the researcher that they participated more in lessons than if this language-use had not been employed. Thus the teacher was able to measure what was understood and what was not. Hence it appeared that the purpose of the language-practice of code-switching in the context of eliciting within mathematics discourse was to enhance the teachers' understanding of what the students knew, and hence the teachers gained a greater insight into what the students did not know. In addition, when examining the verbal interchanges that involved explaining, this study found that it was normally terms and phrases from the formal mathematics registers which needed elaboration, particularly expressions from the English mathematics register. Through inter-sentential switching, the local language was used to elaborate, paraphrase and summarize the major concept under discussion. Again it appears that using code-switching in this context increased the potential for teachers to effectively guide the learning of the students.

Inter-sentential switching between languages also occurred in the context of repeating. Repeating occurred commonly in three contexts as indicated above: repeating questions, repeating explanations, and repeating students' responses. Repeating questions and repeating explanations served the same purposes as discussed above, but the practices were in line with how cognition processes take place for unbalanced multilingual learners (Clarkson, 2006). When a learner in an unbalanced language background is presented with a concept in a new language, the learner constantly switches into the fluently spoken language, trying to repeat as accurately as possible what was said to make connections to what is possessed as background knowledge to enhance understanding, either mentally or verbally. As the researcher recalls from his own experience as a young learner, such a language process was a mental process only, as English as a foreign language was only allowed to be used for teaching, and there was no verbal articulation in a local language. In such a situation, the learning was slow because the students were undertaking such mental processes, but without realizing the teacher had sped ahead in his/her teaching. However, in the present study, when a teacher repeated a term or phrase, the students followed the pattern of the teacher's thinking and the speed of the lesson was regulated more to the students' progress of cognition. Hence in this context it is likely that when a teacher repeated a question in the local language, the students were given the opportunity to understand and respond not only accurately but in a relatively short time after they were asked. Similarly, when a teacher repeated an explanation in the local language, the students were assisted to understand what was being explained in the lesson through the switching of languages if needed. Therefore, the teachers' practice of repeating questions or explanations when teaching, probably helped these unbalanced multilingual students to process ideas mentally and keep up with the speed of the lesson. Thus, one hopes they were guided far more effectively in their learning than the researcher was as a young learner of mathematics.

Another strategy that teachers used in their teaching was repeating students' responses. Mercer (1995) emphasized that to guide students' learning teachers need to respond to what learners say. He noted that one of the ways teachers can respond is to repeat what the students say. This was observed in the present study. The purpose of such ways of talking in the present study was to confirm or reject what the students publicly shared in the classroom. The responses of the students were mainly in the local language, but as part of the teachers' repeating of students' responses, the teachers started to confirm what was suitable mathematical expression in the local language, but also led students to the formal mathematical expressions in English soon after. Hence it appears that the purpose of the teachers' repeating of students' responses was not only that students received feedback on their attempts to answer questions and hence grew in their knowledge, as Mercer had earlier opined, but in this multilingual context it also confirmed and incorporated what students said into the flow of the discourse, but often elaborated that with a shift to English.

Effective mathematics discourse in a classroom does not happen in isolation. There are always elements of non-mathematics discourse in each lesson (see Figure 7.1), and these often play a major supportive role to enable the mathematics discourse to be effective. Because of space limitations, this study focused on only one type of code-switching within non-mathematics discourse, that is, inter-sentential switching. As indicated earlier, the general purpose of inter-sentential switching within non-mathematics discourse was to support and promote mathematics discourse. This was specifically observed in code-switching observed as part of teacher communication that took place in both contextual discourse and regulatory discourse. The aim of talking within these discourses when inter-sentential switching was observed was to regulate student behavior. The pattern observed was alternations between either of the local languages and English.

Again in this non-mathematics discourse code-switching was examined in the contexts of teachers questioning, instructing, and repeating an instruction (see Figure 7.1). In summary, the ways teachers talked had the aim of regulating both the physical and mental behavior of students. For this to occur, teachers used strategies that involved questioning, instructing, and repeating the instructions. The questions asked after code-switching in non-mathematics discourse were not for eliciting purposes, as was found within mathematics discourse. Here the aim was to manage the classroom behavior. The questions were commonly asked in English, but in some cases they were also asked in the local languages. The questions commonly asked in English were mainly for regulatory purposes. The questions in English promoted the authority of the teacher, and thus helped manage the behavior of the students. The few questions that were asked in the local languages were also for regulatory purposes, but required students to fully understand what they were required to do; thus these questions played an important part in the progress of the lesson. Similarly, the overall aim of instructing and repeating instructions after inter-sentential switching was also for the purpose of regulating behavior. Using these strategies was one way that the teachers managed the flow of the lesson, and hence facilitated the success of the related mathematics discourse.

As indicated, the regulatory discourse was mainly in English, but this was not only to promote the authority of the teacher using the new language which had status, but to give more access to students to hear the general English used by their teacher. Therefore, the purpose of code-switching within non-mathematics discourse may not have been related directly to guiding learning of mathematics, but contributed indirectly to ensure mathematics discourse took place successfully, hence contributed to guiding the unbalanced multilingual grade 3 students to learn effectively.

This section aimed to answer the question related to the purpose of code-switching within the teaching process. It showed that the general aim of code-switching was to guide effective learning of unbalanced multilingual students. Such an aim was found mainly within mathematics discourse, but non-mathematics discourse indirectly supported the same purpose. The purposes of code-switching discussed in this section were mainly descriptions of what was observed through the teaching process. The following section will discuss and compare what the teachers said were their intended purposes of code-switching in their teaching. As indicated in Chapter 4, such results were gathered through semi-structured interviews with individual teachers. The interview incorporated watching aspects of a video of the teacher teaching earlier on the same day.

7.4 What were teachers' perspectives of using the local languages and English in teaching?

In the earlier section the discussion dealt with the observation results from the classrooms. This section discusses the connections between these linguistic teaching behaviors and the perspectives and beliefs teachers had that were revealed during interviews. Generally, this study found that there were two complementary views held by the teachers that influenced their use of code-switching in the teaching process.

On one hand, teachers had very strong views that English, in this case mathematical English, was important. They wanted their students to have access to this language through their verbal communication within the teaching process as early as grade 3, the first grade of primary school education. The main reasons that the teachers gave in support of this view were related to using English for future employment and communicating with the rest of the world. The teachers believed that when the students have access to English as early as grade 3 and over the period of schooling during primary and secondary education, students would have learned enough English before they entered job training or different tertiary institutions.

On the other hand, the teachers had a strong view that successful learning was possible only if the students understood the new mathematics concept being taught. The teachers implied that using English only in teaching did not promote deep understanding at grade 3 because these students were being introduced to the language for the first time in this grade. Therefore, to help students understand the mathematics being taught, the teachers strongly believed that they should use the fluently spoken local languages as a teaching resource within the teaching process. The teachers believed that, by using the local languages, the students would more easily come to understand the mathematics concepts being taught, and this would help guide the students to learn successfully.

These two perspectives were complementary even though, as pointed out earlier, the teachers did not explicitly say so in the interview. It was clear from what they did say in the interview, and was consistent with the teaching processes they employed (discussed in section 7.3), that what the students really needed to understand were mathematics concepts expressed in English. In particular the students needed to learn key aspects of the English mathematics registers, or formal expressions such as definitions. They clearly said that by using the local languages, particularly through code-switching, they tried to help students understand mathematics concepts. But they felt it was also important that the students understood the related mathematical English. Therefore, the overall perspective of the teachers was that they set out to help students understand mathematical English that expressed mathematics concepts. Thus they needed to code-switch and use the local languages as a teaching resource. In this way the local languages used as a resource to help understanding and guide the learning of mathematical English became the intended purpose of code-switching.

With these perceptions as a foundation, other implications from their teaching came into play. During the interviews teachers suggested that when they became aware of certain factors within the teaching process that suggested that their students did not understand the ideas being discussed, this consequently stimulated the teacher to code-switch and use the local languages. There were four factors associated with this finding that were identified from the interviews. First, the teachers viewed that the benefit of using the local languages in teaching was that there was greater encouragement for students to participate orally. This in turn meant that there were more frequent opportunities for the teachers to gauge what was misunderstood, and indeed understood, through what the students were freely saying, mainly in a local language. When a misunderstanding was spotted in a student response, then the teachers normally code-switched and shifted to a local language to help students understand. The teachers suggested, probably quite rightly, that this strategy resulted in more effective learning. The example of such talking and responding was part of eliciting as described earlier, and also in Chapters 5 and 6.

Second, when the students were not quick to respond, teachers believed that this was an indication that there was at least partial misunderstanding. This type of episode occurred normally when the teacher was asking the students a question, or when they paused during the conversation so that students could response and show whether they were following the conversation. When the teacher noticed a delay from the students, then s/he believed there was probably a misunderstanding that hindered the students from following the conversation. Therefore this stimulated the teacher to believe that there was a need for a language shift to a local language to help the students understand and so that they could respond and effectively negotiate their learning orally.

Third, there were certain body gestures from the students that the teachers read as signs of misunderstanding. These stimulated the teachers to deploy code-switching and use a local language again to help students understand. The most common gesture noted by teachers in the interviews was facial expression that clearly showed the students were confused.

Finally, if a teacher judged the content and context of the mathematics presented to be of high difficulty, the teacher code-switched to a local language. Again their given reason for this was predominately to help students understand. The occurrence of this according to teachers was mainly when they were explaining mathematics ideas. This aspect of the interview findings clearly correlates with the earlier discussions of the observation data. The teachers commonly presented the concepts in English and, later, according to their judgment, would shift between languages and use a local language to explain, in the hope that students would understand the new mathematics concepts.

To conclude, this section described some of the fundamental views teachers expressed during the interviews that they believed influenced their language practice of code-switching. These teachers expressed views as to why they code-switched. These matched closely the deduced purposes of why code-switching was observed during the teaching of these teachers. The teachers clearly believed that for their students to learn mathematical English effectively, with understanding, they the teachers needed to code-switch. This in turn meant that they saw the local languages as a teaching resource rather than teaching mathematics in the local languages as an end or priority in and of itself.

In the process of discussing the teachers' purposes for employing code-switching in their teaching, both in section 7.3 and in this section (7.4), the role of local language became apparent. Since the role of the local languages in teaching was the central aim of this study, the following short section will focus specifically on the identified roles of the local languages as seen in the observed teaching and as expressed in the interviews.

7.5 What were the roles of the local languages in teaching?

In the previous two sections, the perceived purposes that the teachers had for using code-switching were described, referring to the results from observed classroom teaching and the perspectives of teachers expressed during individual interviews. It seems clear that the teachers' perspectives given during the interviews on the purpose of code-switching matched their linguistic behavior observed in the lessons. It also seems clear from these data that the teachers strongly believed that to guide students to learn the mathematics they were teaching meant in part that the students needed to learn the appropriate mathematical English effectively. In other words students needed to understand the mathematics concepts expressed through the mathematics registers, but in particular the English mathematics registerand the associated formal mathematical expressions. For this to occur with their grade 3 students, the teachers needed to use the local languages that the students spoke fluently as a resource in their teaching. This perception obviously was in play in the teaching practices discussed in section 7.3. The teachers indicated that, before they utilized code-switching strategies and shifted to or between the local language(s), there were certain factors that assisted them to make this decision. These factors included a moment of hesitation in the students' response that was interpreted as misunderstanding, a silence or pause when the teacher expected a rapid response from students, a body gesture that suggested misunderstanding, or the teacher's judgment that the content or context was maybe too hard for students to understand. These factors served as signs for teachers to believe there was possible student misunderstanding, and in response they deliberately code-switched in an endeavour to help students understand the mathematics.

However, coincidently there was another aim that paralleled the teachers' desire for their students to become competent in mathematics. This was clear within the way teachers carried out the language practice of code-switching to enhance their teaching processes. The purpose of code-borrowing was deduced from the way sentences were constructed. A local language was used for the verb phrase of a sentence. In many cases this helped to describe, define, explain and promote the noun phrase, which was a borrowed term or phrase from a mathematical register normally in English. Similarly, the local languages were used in different ways using inter-sentential switching also to enhance students' understanding, but also to promote the understanding of English. Through eliciting, teachers aimed to find out what students misunderstood and help them understand. Similarly, when a teacher presented a difficult concept, the teachers code-switched and used the local language to explain and aimed to help students understand. In addition, teachers repeated questions and explanations in the local language, also to help students understand what was asked for. They also used the local language the students spoke most fluently for explanations. Furthermore, the teachers repeated what students said as a way to approve what was to be shared knowledge in the class and reject what was not, helping students understand the expected shared knowledge of the lesson. In summary, these results obviously indicated that the role of local language was to help students understand both mathematical English and related content. However, the sum total of these language strategies used by the teachers meant that students were learning the importance of English, and becoming fluent in mathematical English, a result that had the full approval of the teachers.

It is also useful to note that these outcomes confirm that the teachers in this study were implementing the new language policy that recommended the use of local languages as a resource to introduce English, in this case mathematical English.

7.6. Conclusion

The main purpose of teachers in this study in using code-switching as a teaching resource in their multilingual classrooms was to effectively guide the learning of mathematics. Specifically their aim was to guide the learning of unbalanced multilingual students who were learning English for the first time, as an additional language to their fluently spoken local languages (*Wahgi* and *Pidgin*). To achieve this, the teachers believed that they had to shift between languages at the right time. The 'right time' was judged by 'hints' from students that the teachers looked out for. The way the local languages were alternated and used in this study suggested that teachers aimed to help students understand mathematics concepts, but in particular concepts that were expressed in mathematical English. Therefore, the role of the local language in this context was as a resource to enhance this understanding. This was part of the fundamental perception of the teachers in this study; that is that their students needed to understand deeply the mathematics they were studying, not just learn surface techniques. In such a language context in grade 3, the effective means to help understanding was to use the fluently spoken local languages as a resource, with the purpose of helping students understand, thus contributing to effectively guiding them to the learning of mathematical concepts, as well as of mathematical English as a language of mathematics.

8.1 Introduction

This chapter summarizes the outcomes of this thesis by addressing four significant areas. The first section highlights the main reasons behind the key research question that guided this study. The second section revisits the main findings of this study presented in Chapters 5 and 6 and discussed in Chapter 7. The third section discusses how and why this study is significant for different groups, including the researcher as a teacher educator, classroom teachers, policy makers and other researchers. The fourth section highlights the limitations of this study so that the main findings of this study could be read within a legitimate picture. The fifth section of this chapter aims to present some recommendations so that this study will be read as part of a progressive process either in policy making, teaching practices or future research. To begin, the following section reflects on the fundamental reasons behind the main research question that guided this study.

8.2 Fundamental Issues and Interest behind the Research Question

As indicated in a number of earlier chapters, the main research question was to determine the role of local languages within the teaching process in multilingual mathematics classroom in grade 3 classes. This question was influenced by three fundamental and interrelated issues and interests. The first was the interest to assess the implementation of the new language policy that the Government of Papua New Guinea established in 1992. This was a change made to the old policy, established after independence in 1975 from Australia, which had required all classrooms to use English strictly as the language of instruction. The new policy of 1992 continued to place emphasis on teaching in English, but aimed to use local languages as a resource to promote English in the early years of schooling, particularly in the lower primary sector. The specific aspect of the language policy this study targeted was to assess what was happening in grade 3, the so-called bridging year. In this grade it was recommended that local languages should be used frequently in teaching, indeed should be the dominant language(s) used, but with the aim to introduce English. However, the policy also deemed that the use of the local languages should decrease over this year, and in succeeding years, so that English would become the dominant language of teaching in grades

4 and 5. This policy recommendation assumed that the students would be guided in their learning so that they developed confidence in using English in their learning of all subjects, including in this case mathematical English. Thus the policy aimed far higher than students just learning conversational English. Through the careful use of the fluently spoken local languages in the classroom, it was anticipated that English would become the dominant language of instruction. Thus this study aimed to assess the role the local languages played in teaching mathematics concepts in grade 3, but also to investigate whether during this process, teachers were trying to introduce mathematical English.

The second interest in this study was a personal one. This interest related to the researcher's schooling experience under the old language policy and his hope that the new language policy might help prevent any repeat of that experience for present day students. As indicated in Chapter 1, the researcher had a very negative experience in his primary schooling when the old language policy was in place that required both the students and teachers to use only English in classrooms situations. The researcher began school with no English background and was forced to talk in English from the beginning of primary education for 6 years. The best he did over the 6 years of primary education was either to take the safest way out by being silent at all times in the classroom, or produce one or two English words as his verbal response when he had to. Over those 6 years he never created a sentence in English by himself. At times the researcher, as a primary-grade student, had some idea of what was going on in his classroom during teaching sessions, but he could not participate because he could not communicate in English. Therefore, when the new language policy recommended that the fluently spoken local language should be used as a resource to introduce English, and hence support the teaching of the different subjects, the researcher saw what difference it could make for students in their communications within their classrooms, and therefore supported this policy. He knew finally that the students in the lower primary-school sector would never again have to go through the same experience he had endured. However, just having a supportive opinion was not enough for the researcher. He wanted to know if the new policy was not only implemented, but having educational benefits for both teaching and learning. Such interest motivated the researcher to generate the key research question for this study. He recognizes that the first of these, teaching, has been the focus of this study. The anticipated benefits for student learning, his second concern, has not been the subject of this thesis and will have to wait for further research to be undertaken. But he also notes that the research literature situated in other contexts strongly suggests that this will also be the case in Papua New Guinea.

The third issue that was an important motivation for the researcher was related to a realization that classroom teachers are important people in making sure any education policy is implemented. Such interest originated from the fact that the researcher was a teacher educator at the time when he began writing this thesis. From this interesting intermediate position of not being a teacher in schools, nor a policy maker, it became apparent that the aspirations that influenced the policy makers to create or endorse policy at the national level are rarely the same as what is perceived by the teacher. Even if the two groups see the same policy, the teacher's view is always conditioned by the reality in the schools, and this inevitably encourages teachers to make variations suitable for their classroom contexts. In addition, the reality at the classroom level as assumed by the new policy seems never the same as what happens within the classroom. Thus, the teachers play an important role as implementers, whether the policy makers like it or not. The teachers make important decisions in line with the new policies, but such decisions are tailored so as they are seen to be suitable for the classroom situations they are in. In addition, the policies will be nuanced so they fit the perceptions of the teachers. In the case investigated in this thesis, the policy assumed that the local languages could be used as a teaching resource to introduce English, in this case mathematical English. The policy in fact gave teachers freedom to decide which local language to choose. When such freedom is given, the teachers' perspectives come into play in a major way. The languages available under this policy are seen by the teachers to be like any other teaching resource. But how they are used is inevitably influenced by the teachers' views of enhancing teaching.

There was evidence as to what teachers might do from the research literature that studied the implementation of similar policies, such as those from South Africa. This was reviewed in Chapter 3. The policy in South Africa gave teachers the freedom to use the local language(s) as a resource. But in the majority of classrooms studied, due to the perspectives of teachers, the common practice was not to use the students' fluently spoken local languages in public classroom verbal communication, but to use only English. On the other hand, the students were allowed by these teachers to use the local languages in their group discussions and in one-to-one communication with the teacher or peers. This teacher decision seemed to be in response to a tension that existed in terms of a variety of views related to the importance of English, and how the use of local languages might not promote English. The teachers perceived that using only English would give their students more access to English early in schooling, and that using other languages might interfere with the learning of English. The English language was perceived to be important since it was known that the students would need to be fluent in it for good future employment. Therefore, the students were allowed to use their local language among themselves, but the teachers' response to students in public was only in English. This approach by the South African teachers was only partially in agreement with much of the research reviewed in Chapter 3. That research strongly suggested that students will be advantaged if they are encouraged to use all their languages in the learning of mathematics.

The teachers in Papua New Guinea had the same freedom to use the local language or not in their teaching, as did the South African teachers. Therefore, this research aimed not only to assess the implementation of the new language policy as indicated earlier, but also sought to delve into the perceptions of the teachers that may have influenced them either to use or not to use the local languages as a teaching resource when teaching mathematics. Such a result was important for the researcher on two levels. First, it was important to the researcher as a teacher educator to know what were teachers' perceptions on the use of the local languages. This knowledge would be able to inform teacher education programs in mathematics education. Second, these results would be interesting in that they could add to the current research in the literature.

These three motivations all had an impact on the design of the research question for this study. The following section discusses the main findings of the study.

8.3 Revisiting Important Results

There were a number of important results found through this study that are discussed in this section. It begins with a comparison of the context and related practices of the classrooms in this study with what was assumed within the new language policy of 1992. The study showed that, at least in the classrooms observed, there was a multilingual context where *Wahgi, Pidgin* and English were used for teaching. All three languages were used for the language practice of code-switching.

This study targeted the role of local languages, specifically in the language practice of code-switching. This section briefly summarizes the general purpose of code-switching and the role the local languages played to promote mathematics registers, but particularly the English mathematics register, and in turn promoted the importance of English per se. The following sub-section begins by comparing the language context and practices found in this study with what the new language policy had assumed.

8.3.1 Classroom Language Contexts and Practices Compared with the New PNG Language Policy

As indicated earlier, one of the main aims of this study was to assess the new language policy. There were a number of interesting findings from this study in comparing the recommendations of the new language policy to what was happening in the observed classrooms. First, the language context recommended in the new policy for rural bottom-up primary school was bilingual. The assumption of this recommendation was that only one of the 817 languages would be used in rural schools, and one of the two national local languages in urban schools, to introduce English. In this study, with its emphasis on mathematics, this recommendation translates to using one of the vernaculars to introduce mathematical English. However, this study found that the classrooms observed were multilingual, because the teachers more often than not were using three languages in their teaching. As indicated in earlier chapters, the three languages were *Wahgi, Pidgin* and English. The schools involved in this study were rural primary schools and, according to the policy, it was assumed that *Wahgi* would be used only to introduce mathematical English. However *Pidgin*, which the policy assumed would be used in urban schools, was also used extensively in these rural schools.

Second, the new policy also specified the frequency of each language that should be used for each grade from grades 1 through 8. The focus of this study was on grade 3, the so called bridging year when teachers began the introduction of English, using the local languages as a resource. Hence the policy indicated the language frequency recommended for grade 3 was 60% of local language to be used as a resource to introduce 40% of English. Since the policy did not assume more than one local language would be used to introduce English, it did not make a recommendation on how much of each local language would be used to introduce English. Noting first that the teachers in the classrooms observed in this study used three languages rather than two, it was assumed that the percentage time use of local languages would add up to 60%, and English should continue to be 40%. Therefore, this study calculated average language use over the 16 lessons observed. The results showed that the teachers implemented the balance of language use, between the local language and English, as recommended by the new policy. Between the two local languages, the sum of their average use of *Wahgi* (17.6%, see Appendix 5.2) and *Pidgin* (51.6%, see Appendix 5.2), were close to 70%. Similarly, the average use of mathematical English (22.8%) was somewhat less that the 40% recommended by the new policy (It will be recalled that in calculating the whole classroom verbal interchanges a small percentage was referenced student talk, which accounts for the ‘missing’ 8% in these figures). The amount of each language was slightly different, but the view that more local languages should be used to introduce English was maintained. Therefore, from the small number of lessons observed, this study suggests that the teachers implemented the policy related to the frequency of using local language to introduce mathematical English.

Third, it was not only interesting that *Wahgi* was not the only local language to be used to introduce English, but it was noted that *Pidgin* was used more frequently than *Wahgi*. As indicated earlier, *Wahgi* was the local language and, according to the policy assumptions, *Wahgi* should be used frequently to introduce English. The policy assumed that if the teacher realized that their students were a mixture of language speakers, they would use *Pidgin*. But it was assumed this would happen only in urban schools. The policy seemed to assume that this was unlikely to be the case for rural schools, because the students were locals and came from the rural Elementary Schools (grades 1 and 2) that used 100% of *Wahgi* for teaching and learning. This being the case, the finding that teachers would deliberately choose *Pidgin* more frequently than *Wahgi,* was somewhat of a surprise. However, it was not the focus of this study to investigate why *Pidgin* was a more frequent choice than *Wahgi* in the teaching that was observed, and by the time this result emerged, data collection had been completed. But it might be useful to speculate on why this was so, based on my experience as a local member of this cultural group and an experienced teacher. I assume that the teachers thought *Pidgin* was related to English more than was *Wahgi*, and to promote English as recommended by the new policy, there would be an advantage for the students to use more *Pidgin* than *Wahgi*. The comparison of the relationship between *Pidgin* and English was not the centre of this thesis. But these languages were related in terms of phonics and semantics. Most of the words used in *Pidgin* have similar sounds (phonics) and meaning (semantic) to those from English. To promote both understanding of mathematical concepts and mathematical English, I think teachers decided to choose *Pidgin* more frequently than *Wahgi* for teaching. There is a need for further studies related to such language choice as this, and the reasons for teachers making such selections.

Fourth, since three languages were used for teaching in one lesson, this study found that the teachers were using the natural language practice of code-switching. This language practice enabled the teachers to shift between the local languages, and from them to English, and back again. The study's main target was to distinguish the role of local languages, and to do this the researcher chose to focus specifically on code-switching. The results concerning code-switching will be summarized in the following sub-section. However, it is interesting to note here that the new language policy did not explicitly acknowledge, nor even mention this language practice of code-switching. It might have been implied within the descriptions related to 'bridging processes'. According to the new policy, the recommendation said that the local languages should be used as a bridge (resource), to help the English language cross the bridge successfully. When two or more languages are to be used together, one as a bridge or resource to promote or make transition easier to the other, no bilingual or multilingual will escape the natural language practice of code-switching. Hence, the new policy described how these languages could be used as part of bridging process, but strangely it did not acknowledge the use of the natural language practice of code-switching. As Skiba (1995) said, code-switching does not only involve language shifts, but also involves skills learnt as part of learning the second language that would help one use language purposefully to achieve effective communication. The particular communication process at the centre of this study was that that took place during mathematics lessons, particularly during the whole-class teaching process. In this context the teachers used the skills of code-switching to enable purposeful use of both the local languages and English to enhance effective teaching. In this case, the local languages could be purposefully alternated through code-switching as a resource to promote mathematical English. Such a language process provided effective ‘bridging processes’ as indicated by the new language policy. In a revision of the policy it may be advantageous to acknowledge the important use of code-switching.

8.3.2 Purposes of Code-Switching and Role of Local Language

The major aim of this study was to distinguish the role of local languages when used as a resource, or bridge, to introduce English, in this case mathematical English and mathematical content. Such a language-use in teaching involved the language-practice of code-switching. This study chose the moment when a teacher code-switched and alternated the local language for teaching process. To determine the role of the local languages, the purpose of code-switching had to be determined, and this could take place while examining the language-practice within teaching process. The detail analysis was presented in Chapters 5, 6 and 7. Briefly, since the learners were unbalanced multilinguals who were learning English related to mathematics for the first time, code-switching was used to access their fluently spoken local languages, in this case *Wahgi* and *Pidgin*, to bridge to the meaningful use of English. Specifically in terms of the language-practice of code-borrowing, the local languages were used as verb phrases within sentence structure to promote the noun phrase, mainly mathematics registers expressed in English. The verb phrase forming most parts of a sentence was constructed in the local language contributing to defining, explaining or contextualizing the noun phrase used mainly as term/phrase. Similarly, the local languages were alternated through inter-sentential switching to ask questions as part of eliciting, explaining or repeating (mainly questions and explanations). Such ways of talking in the fluently spoken local language were interpreted to help students understand the questions asked and concept explained. This was interpreted from results obtained by observing teaching process. This was confirmed through interview that teachers intentional code-switched and used the local language to help students understand in order to learn mathematical English and mathematical content successfully. Therefore, the purpose of code-switching within the mathematics discourse was to enhance the teaching process so that it could effectively guide unbalanced multilingual students to learn mathematical English and mathematical content successfully. The role of local language in this language practice was to help students understand formal mathematics terms expressed in English, and questions asked as part of explicating and explanations. Therefore, the role of the local languages in this case was obviously to help students understand in order to learn mathematical English and mathematical content successfully.

In Chapters 5 and 6, details of the practices of code-switching were described and the use of the local languages was specified to show how code-switching was used and the role assigned to the local languages was utilized within the teaching process. Briefly, it was shown that to guide students to learn effectively, the teachers code-switched using the local languages to ask questions as part of eliciting, explaining, repeating questions and repeating explanations, in both procedural and conceptual discourse. The role of the local languages within these ways of talking was to help students understand. Specifically, the local languages were used to help students understand questions asked as part of eliciting so they could effectively participate in the discussion. The local languages were also used by repeating a question that was asked earlier in English, and also for further explaining or repeating an explanation that had been presented earlier in English. The teachers believed that by students understanding the questions through the use of the fluently spoken local language, it would ease the language challenge posed by mathematical English as a foreign language. Thus teachers helped guide the unbalanced multilingual grade 3 students to learn successfully.

The type of code-switching involved ways of talking that helped the researcher determine the purpose of code-switching. One role used for the local languages was inter-sentential switching. However, this was not the most frequent type of code-switching used by the teachers. This study found that the most frequently used type of code-switching was code-borrowing as part of intra sentential switching. The following section discusses this result, aiming to further show in detail how such a language practice aimed to guide the students to learn mathematical English successfully by using the fluently spoken local languages as resources.

8.3.3 Promoting Mathematical English and Mathematical Concepts

In an earlier section, the researcher indicated that the main purpose of code-switching within the teaching process was to guide unbalanced multilingual students to learn effectively. This section highlights the finding related to code-switching. The teachers appeared to have two deep assumptions underlying the use of this process: they were teaching the students mathematical English, and as well this would lead to a deeper understanding of the mathematical concepts being taught. Clearly these two outcomes are intertwined and in fact they exist together. Therefore they must be learnt in the same process. As discussed in Chapter 2, it is hard to differentiate the order in which language and knowledge are learnt. Similarly, it is hard to differentiate whether mathematical English was taught before mathematical concepts or vice versa. It is not the focus of this study to investigate this argument, or to deliberate on whether such as investigation would be worthwhile in any case. However, according to the observations of the teaching in this study, and from personal reflection as a multilingual speaker, it was clear that teachers aimed to promote understanding of both mathematical English and mathematical concepts in the same process. This section aims to show how the practice of code-borrowing was used within the teaching process to promote such learning.

In order to understand how mathematical English was promoted through code-borrowing, while the more frequently used languages in teaching were the local languages (specifically *Pidgin*), it is instructive to reflect on how a general language is learnt by a beginning learner. Generally, a beginning language-learner would be taught to learn phonics and semantics of important terms/phrases from that language, both as nouns and as verbs, before learning to construct a sentence in a language. This involves learning sounds related to each term/phrase and the associated meaning. As students learn more terms/phrases, they are eventually introduced to the grammatical rules of stringing these together to construct a well-formed sentence. In this phase, the students are taught to understand that a sentence has two parts: a noun phrase and a verb phrase. At the same time, the students learn that noun phrases are important and they are the central focus for the verb phrase that supports or promotes them. This would be a normal procedure for learning a new language. Such a practice was found happening in the mathematics teaching, but in a unique way within a multilingual arrangement. The terms/phrases concerned in this study mainly belonged to the mathematics registers, but they were commonly expressed in mathematical English. Most of the terms from the mathematics register expressed in English, and borrowed within sentences constructed from one or other of the local languages are listed in Appendix C: 5.5. As explained in Chapters 5, 6 and 7, the borrowings from the English mathematical register were used within the sentence-structure as the noun phrase. This meant that the verb phrases were constructed in a local language, promoting the English terms found in the mathematics register, since these formed the central part of the sentence-structure as the noun phrase. Within the grammatical rule of sentence-structure, the meaning of mathematics terms were elaborated, defined and contextualized for effective understanding, thus resulting in presumably successful learning (The success of the student learning was not gauged in this thesis, but is attested to elsewhere in the literature as noted in Chapter 2). As indicated earlier, the teachers aimed to construct sentences and thus talk in such a way that their students could understand and learn successfully the meaning of each mathematics term, and the related mathematical concepts, thus contributing to the learning of mathematical English.

With this in mind, it was not a surprise to find that the common teaching approach observed for all eight teachers in this study was to guide students to learn mathematical English related to the lesson topic, principally by introducing important terms and phrases from the English mathematics register, and elaborating their meanings. Teachers in this study understood that English, in this case mathematical English, was a foreign language being introduced to the grade 3 students for the first time. What was more interesting, as discussed in Chapter 5, was that such targeted teaching was occurring by using the local languages, more often in *Pidgin*, as the more frequently used language of instruction than English. The approach used in the teaching process to promote mathematical English was through the language practice of code-borrowing; most frequently burrowing terms/phrases from the English mathematics register and embedding them within the grammatical rules of sentence constructed in one or other of the local languages. The detailed description in Chapter 5 indicated that these borrowings were used as a noun phrase and the rest of the sentence constructed in the local language formed a verb phrase. This was the most frequent teaching technique observed throughout this study.

An alternate view as to why the practice of code-borrowing occurred so frequently in the teaching observed was because the local languages did not have a mathematics register equivalent to that found in English. This view may not be always be true for all the mathematical teaching contexts found in the classroom, because ethnomathematical studies described in Chapter 2 showed that many Western mathematical ideas do have equivalent forms in non-western cultures, including *Wahgi*. Lean (1991) and Muke (2001) confirmed that *Wahgi* culture has mathematical ideas, such as a well-defined counting system. However, such a detailed comparison was not the focus of this study. The point this section aims to emphasize is that it did not matter if the equivalent mathematics registers expressed in the local language did not exist. The focus of the teachers' verbal communication during all of the classroom-teaching episodes was almost without exception on the mathematics register expressed in English, and only rarely on the mathematics register expressed in either of the local languages. In section 6.3.4, it was shown that even if there were mathematics registers expressed in local language and used in teaching, teachers used them to promote and support the teaching of those ideas expressed finally in the target language, English.

Such a result relates back to the earlier discussion that dealt with the new language policy. The policy also stated that, within the bilingual classroom practices, the local language should be promoted as well as English. It was not the focus of this study to ask if there was an extensive mathematics register in *Pidgin* and/or *Wahgi* that would possibly match the needed terms and phrases expressed in English, and hence fully serve such policy recommendations. Clearly, as has been shown above, there were some matches available. However, when there were none, what should be the possible way forward for teachers? These questions are important, but could not be entertained in this study since they go beyond its focus. Nevertheless they do speak to future ethno-mathematics studies and will form part of the recommendations in the later section of this chapter.

The results highlighted here would be significant for some people. The following section describes how this study could be significant for the researcher as a teacher educator, for classroom teachers, policy makers and researchers.

8.4 Significance of the study

This study could be significant in many ways for many people and their professions. It certainly was significant for the researcher as a teacher-educator. But it also has potential significance for classroom teachers who work within a multilingual classroom context, policy-makers who have to design policies related to language-use in multilingual classroom settings, and for the wider research community that focuses on multilingual classroom contexts. The following sections describe how this study could be significant for each of these groups.

8.4.1 Significance for the Researcher

The result of this study was significant to the researcher, particularly as a teacher-educator. One of the factors contributing to initiating the main research question was that the researcher was a teacher-educator when the new language policy was introduced. All institutions were to educate new teachers to consider culture and language in their teaching. Therefore, issues related to using local languages as a resource to teach mathematics were new and yet to be in incorporated into mathematics teacher education. At that time, the issue of this use of local languages was a challenge to all departments, particularly mathematics departments in teacher education institutions in Papua New Guinea. The specific issue was related to code-switching and this was not addressed as part of mathematics teacher education, but left to language departments. Whatever was taught in the language departments was suitable for language learning, but did not specifically address learning of mathematics English and associated concepts.

Through this study, the researcher made a personal journey into understanding the effective skills and practices of code-switching that could be used for teaching purposes, particularly those that target and guide the learning of unbalanced multilingual students within a mathematics lesson. This helped the researcher gain the insight that the practices of code-switching could be an effective teaching tool. This related to when and why it could be used to alternate the local languages and English to help students understand and effectively learn both mathematical English and mathematical concepts. In addition, when English is first introduced at the lower primary level, the successful way to introduce mathematical English, at least in these teachers' practice, was by code-borrowing, using mainly the important mathematics terms and phrases related to the lesson topic expressed in English and used as a noun phrase within the talk that frequently used the local language as verb phrase. This personal understanding of the researcher will enable him to help improve the quality of his teaching to educate the new teachers and equip them with these understandings before they enter into their multilingual classrooms. Therefore, the findings of this study were significant to the researcher as part of his personal development as a teacher educator, but hopefully the importance will also be appreciated by other teacher educators as well.

8.4.2 Significance for Classroom Teachers

As indicated earlier, this study targeted the teaching process and how the language practice of code-switching was used as a teaching tool. Therefore, the findings of this study could be significant for teachers in Papua New Guinea, and perhaps others in similar contexts. Since they are people who are in the front line, implementing the new language policy, findings from this study could guide them to understand and reflect on their languages practices when teaching. Being a case study, these results have limited generalisability. Nevertheless, for those teachers who recognize their context as similar to those of the teachers studied here, these results may have relevant messages.

The policy did not specify explicitly the language practices of code-switching and therefore no specific guidelines were set for effective code-switching and alternating the local languages purposefully in teaching. In addition, studies carried out in PNG teacher education training institutions to assess the implementation of the new language policy showed that language issues were not addressed within mathematics departments. The language issues were left to the language departments. But what was taught in the language departments was likely to have been too general and related less to other departments, particularly mathematics. Since, language issues were not specifically addressed as part of mathematics education, most teachers who have already graduated will not have thought through the language practices of code-switching specifically as a teaching tool for mathematics. Therefore, this study could provide guidance to practicing teachers as to how best to use the skills of code-switching and how local languages can be purposefully alternated to enhance communication during the teaching process. Therefore, the findings from this study could also be significant for existing teachers.

8.4.3 Significance for the Policy Makers

This study should be significant for the policy makers because, as indicated earlier, some of its findings suggest the context assumed by the new language policy in fact differs substantially from what is in schools, at least in the classrooms observed in this study. The first adjustment to the policy that should be considered by the policy makers as a result of this study is not to assume that the classrooms of Papua New Guinea are bilingual. The classrooms in this study were multilingual, and in all probability most classrooms in Papua New Guinea will be multilingual. This distinction is important since the dynamic of the classroom, although not explored in this thesis, is probably quite different from that assumed within the policy.

The second set of findings from this thesis that policy makers should consider were related to code-switching. This practice is not mentioned by the new policy. The new language policy recommended a ‘bridging processes’, but did not specify the practice of code-switching, which in reality seems integral to this process. In fact, it specified that the local language will be used as a resource to introduce English, which in the context of this study meant mathematical English. The policy even specified that 60% of a local language should be used in classroom teaching to introduce English, which would take up the remaining 40% of the verbal communication. The new policy at no time acknowledged the language practice of code-switching as a teaching and learning resource. In other words, there was no particular section in the policy which acknowledged that, within the bridging process, the natural language practice of code-switching would in all likelihood take place. Since it was not officially recognized, there were no suggestions as to how best the language practice of code-switching could be used as a teaching tool. Even if it was deemed that a policy statement should not go as far as specifying best practice in terms of teaching, with no recommendations, or at least mention made of this inherent practice at a policy level, there has been no subsidiary documentation flowing from the policy that might guide what appears to be the natural and effective practice of code-switching as a teaching tool to successfully guide learning of unbalanced multilingual students. This is something to which policy makers should pay attention.

8.4.4 Significance for the Research Community

The findings of this study could become significant for the section of the research community that is specifically interested in the language-practice of code-switching within the teaching and learning process in a multilingual mathematics classroom. Considering the literature review presented in Chapters 2 and 3, it was clear that there are a limited number of studies that have been undertaken to more fully understand the language practice of code-switching as a teaching resource/tool. In particular, almost no studies had been carried out to examine the effective use of the fluently spoken local language through code-switching to guide effective learning of both mathematical English and mathematical concepts by unbalanced multilingual students. This study aimed to partially fill this gap.

The findings of this study showed that the combined effect of the language practice of code-switching and alternating the fluently spoken local languages, probably gave a better chance to guide effective learning of mathematical English and mathematical concepts by unbalanced multilingual students. However, these findings could not be conclusive because the research used the design of a case study. Therefore, the results of this study cannot be used to make generalized statements about the practices of code-switching within teaching, but the findings are suggestive and hopefully will stimulate future studies. To upgrade this statement as conclusive, there is a need for larger scale research study. However, the results of this study are significant for future research, since they have the potential to stimulate further study in Papua New Guinea and perhaps in other countries that have similar teaching contexts.

8.5 Limitations of the study

This section describes the limitations of this study. The limitations discussed here are all related to the techniques of collecting and analysing data. This includes the issues related to using western research approaches in non-western contexts, inherent limitations of a case study, and the likely bias attached with data obtained through interviews.

8.5.1 Western Research Approach used in Non-Western Context

One of the obvious limitations of the study was related to the basic approach to the research approach used. As indicated in Chapter 4, this study used an ethnographic research approach and used multiple case studies as the research design. The techniques used to obtain data from selected 'cases' were through observation and interview, which involved the use of video and audio recordings. This study's approach and data collection techniques have Western origins, and using them in a non-western context was particularly challenging.

For instance, a fundamental stance of western research is that data must be obtained in a consistent pattern. But this was not possible in this study due to the geographical and social settings of the participating schools. This study was planned originally to have observations from a certain number of lessons, per term, throughout the year of study. This was to enable monitoring of any shift in the frequency of using the local languages and English. However, lack of road infrastructure made it very hard for the researcher to get to the schools with his research equipment to collect data on specified dates. At times he had to abandon some visits because roads where impassable, and at other times visits had to be cut short. Another factor was the availability of teachers. Teachers would not always return to school quickly after weekends, or they may leave the school for periods of time due to personal difficulties in sustaining themselves at the school. Hence, at times planned observation of teachers' lessons had to be abandoned since the teacher was absent. Given the state of the roads, it was very difficult for the researcher to return to the school on alternate dates to make up these missed observation episodes. Originally observations were planned to occur within one calendar year. When it was clear that not enough data had been collected in the first year, the revised plan was to span over a number of years. However, that meant other difficulties. It is not uncommon in Papua New Guinea for many grade 3 (the first and lowest grade in the primary school) teachers to be moved to upper grades when teachers for those grades were unavailable. Hence grade 3 students could be left without a teacher for some period of time. This had a further impact on the collection of data for this study. In addition, there was at times no electricity in some schools in which data was collected, nor were there local stores able to replace batteries used as backup power sources when they too ran flat. Thus as has been noted earlier, the collection of the data for this study could not strictly conform to a fundamental supposition of western research.

It is problematic at best for western notions of scientific research to be used as the sole bench mark to judge studies carried out in non-western contexts. As noted in the methodology chapter, undertaking research in non-western contexts is very challenging, but nevertheless such challenges do form part of the limitation of the study.

8.5.2 Study Design – Case Study

This study used a research design of a case study, specifically a multiple case-study, and was faced with the limitations that are attached to such study design. In most cases, it is related to making 'generalized' statements using the findings of the study. This section acknowledges these limitations and clarifies how such limitations were considered from the beginning of this study. The reason for using a case-study approach tied into the motivation and original aims for conducting this study. From the start, the main focus of this study was not to conduct it in such a manner so that generalized statements could be made. Instead, the main aim of this study was to understand the role of local languages through the language practices of code-switching within the teaching process. Since this language practice was not well studied, as indicated in Chapter 2, this study needed a small data source to investigate this phenomenon in detail in order to better understand it. Hence, from the outset it was known that any generalized statement made from this study could not be regarded as conclusive and reflective of teaching practices in all multilingual mathematics classrooms, even in Papua New Guinea. It is to be hoped the results will help to begin to describe and explain the existence and purposes of the practices of code-switching within the teaching process for mathematics. Future studies, one hopes, will build on these beginning insights.

8.5.3 Interview as a Technique of Data Collection

As indicated in Chapter 4, one of the means of collecting data was semi-structured interview. In most cases, the interview was carried out to gather data related to the perception of the teacher related to the use of local languages through the language practice of code-switching within the teaching process. One of the inherent limitations in carrying out these interviews was that it was hard to know whether what the interviewee said was a true reflection of their own views. There was no way to know if their views had been influenced by external factors, such as the way the research was conducted, or knowledge of the purpose of the study, the presence of the researcher as a local, and so on. Therefore, the limitation of collecting data by interview is that what is received from teachers, as their perceptions can never be wholly verified in other ways, and hence one never really knows whether their responses are 'true' representations of their views.

One of the ways used by this study to try and combat some of this limitation was by showing the teachers video recordings of their teaching as part of the interview. As well the interviews were carried out on the same day as the teaching episode. In addition, the data analysis deliberately involved comparing each teacher's linguistic behaviour while they were teaching with what they said in the interview. Furthermore, the researcher's own knowledge about the teaching practices discussed with the teachers was also used to make judgements about what the teachers said. Such data-gathering practices and triangulation of data sources has probably reduced the possibility of a large gap between the verbalised perception of teachers in the interview and their unknowable 'true' perception. However, even given the above practices, the inherent uncertainty of the data means it must be categorized as one of the limitations of this study.

8.6 Recommendations

In section 8.3, it was indicated that the findings of this study would be significant for certain groups of people, including the researcher as teacher-educator, classroom teachers, policy makers and researchers. This section provides some recommendations based on the findings of this study that could be considered by these groups.

8.6.1 Teachers of Mathematics Education

In section 8.3.1 it was noted that the findings of this study were significant for the researcher as a teacher-educator. These were not meant to be restricted to the researcher, but may be important for other teacher mathematics educators as well. As indicated, this study found that the language practice of code-switching that enabled the fluently spoken local languages to be alternated within the teaching process, showed potential for helping unbalanced multilingual students to understand and effectively learn both mathematical English and mathematical concepts successfully. Therefore, this study recommends that the skills and practices of code-switching used as a teaching tool should be included as a unit within the primary school mathematics teachers' education course for teachers who are likely to teach in multilingual classrooms, but particularly in Papua New Guinea. Some of the issues recommended for practicing teachers in the following sections could become part of their teacher education too.

In teaching this unit in Papua New Guinea, the approach of lecturing should involve the pre-service teachers in activities that help them reflect on their own language practice of code-switching as multilinguals using their own respective languages. This should lead to critiquing which practices would be of benefit in the teaching process and which would not. In addition, they might consider when should code-switching be used, and when should it not be used. On more than one occasion in this study, there were instances in the recorded data that suggested there were times when code-switching was not a good teaching strategy to use. Hence it should not be considered a failsafe teaching strategy to be used at all times in the classroom. As well the students should reflect on which part of discourse in teachers' talk should it be used. For instance, it seems from this study that teachers should code-switch and use the fluently spoken local language when they are asking questions as part of eliciting, and to explain major mathematics concepts within mathematics discourse. Thus it is recommended that the language practice of code-switching for mathematical teaching practices should be included in the units taught at teachers colleges/universities that train primary school teachers.

8.6.2 Classroom Mathematics Teaching

The findings in this thesis could also become useful for the practicing teachers in Papua New Guinea and perhaps beyond. In most cases, these teachers may have already used the language practice of code-switching. However, they may have never been stimulated, nor have had the time, to reflect on this natural language practice of code-switching and recognize how it affected their teaching, both in positive and negative ways. Since this study found that the practice of code-switching had potential to become a useful explicit teaching tool, the following recommendations are made to help practicing teachers to improve their language practices:

- Shifting language through code-switching should not be haphazard and random, just to give a chance to use another language. The practice of shifting between languages should happen purposefully, and it should make teaching effective, guiding successful learning.
- Avoid frequent code-switching, which can be more confusing than helpful for students.
- Since the fluently spoken language is used throughout code-switching aimed at understanding, conceptual discourse should be used frequently in teaching.
- Since English is first introduced at grade 3, the phrases from the English mathematics register should be frequently and purposefully code-borrowed within the context of mathematics discourse.
- When code-switching and alternating between local languages to ask questions as part of eliciting, teachers should avoid answering the questions themselves, but give enough time to students to respond as part of their learning.
- Know that the students' answers are likely to be in one of the local languages in grade 3. Use that, but also be prepared to ask students to shift to English when appropriate.

8.6.3 Policy

From the literature reviewed in Chapter 3, it was clear that the new language policy has explained the purpose of language use within the bridging process. It did not explicitly acknowledge the practice of code-switching that was possible when the local languages were to be used as a resource to introduce English, in this case mathematical English. This study found that the language practice of code-switching was a useful teaching strategy. However, the policy did not specify guidelines for an effective practice of code-switching and using the local languages as an alternate language as a resource to help introduce mathematical English. Therefore, there is a need to expand the notion of the bridging process by including in the policy, or in related subsidiary documentation, material related to the language-practice of code-switching. The following are some recommendations for the policy makers in Papua New Guinea.

- The definition of the bridging process should further be refined by acknowledging the language practice of code-switching. This would enable an explicit strategy to be noted that would enable the purposeful use of the local languages.
- Code-switching practices used by teachers should aim at enhancing effective teaching to successfully guide unbalanced multilingual students to learn successfully.
- After thorough research, different practices of code-switching should be recommended for different grades, and the language emphases that should be given.
- The relationship between the frequently used language and code-switching to use other language(s) as a resource should be investigated and, in time, recommendations made. For instance, in grade 3 the local languages should be used frequently, but through using code-switching in a purposeful manner, the promotion of mathematical English should be aimed for. However in grade 5, English should be the most frequently used language, but through code-switching, the local languages should be used as a resource to help student understand and effectively learn.
- The policy should advise when would be an appropriate moment(s) for teacher to meaningfully engage in the language practice of code-switching. This study found that it was important to code-switch and use the fluently spoken local language when questioning as part of eliciting, and explaining major mathematics concepts. This finding needs to be explored in other settings, but it gives the feel for what could be recommended.

- By drawing on research, the policy should recommend and give examples of successful practices of code-switching to guide teaching and learning.

8.6.4 Future Research

The future research that should follow this study could be on a much larger scale to confirm statements made from this case study. It should be a study with improved, or at least different, data-gathering techniques, since this is an acknowledged shortfall of this study. Future studies should also extend the investigation to other language areas in Papua New Guinea, and elsewhere, to ensure the findings here are not just artefacts of a peculiar language-context found in these schools and from using *Wahgi*. Since this study was a case study and the findings could not be used to make conclusive statements, it is hoped that these findings will stimulate research questions for future studies. The following are some discussion points that may provide useful starters for such future studies. They are related to code-switching, cultural mathematical ideas that could be used while alternating local language through code-switching and the impacts of using *Pidgin* for both learning and teaching.

8.6.4.1 Code-Switching

The focus of this study was not directly related to understanding how code-switching was used as a teaching tool. As indicated throughout this thesis, this study aimed to distinguish the role of local languages, while they were used as bridges and resources to introduce English. The new language policy described this as a 'bridging processes' but failed to acknowledge the possible use of the natural language-practice of code-switching. While this case-study was conducted to distinguish the role of local languages, the natural language-practice of code-switching became obvious within the teaching process during the data-collection process. What became a central finding of this study was that, during the language practice of code-switching, the local languages seemed to be purposefully alternated and used to enhance the teaching process. In most observed lessons, the teachers seemed to possess certain skills of code-switching that enabled them to shift deliberately and alternate the fluently spoken local languages when there was a need for students to understand what they were teaching. Hence it is no surprise that this study chose the moments in teaching that used code-switching as the critical times to investigate. The approach used in the data analyses as described in Chapter 4 was to first establish the general purpose of code-switching, and then later identify the role of the local languages within the overall use of code-switching. As indicated earlier, this study found that the general purpose of teachers in using code-switching was to guide unbalanced students to effectively learn. The role of a local language, when used as an alternate language was to support this general purpose of guiding students to learn effectively through code-switching the mathematical English and related mathematical concepts. In other words, the role of the alternative local language in this case was to promote understanding, specifically the mathematical English used and the meaning it expressed.

As indicated through the literature reviewed in Chapter 2, there have been enough studies carried out elsewhere to understand how the language practice of code-switching has been used as an effective tool by students for learning (Clarkson, 2007; Setati & Adler, 2001; Setati, 2005). But very little research has been undertaken to understand how it could enhance teaching. This case study showed that the teachers in this study were using the language practice of code-switching as a tool in their teaching, guided by their government's new policy. As to whether this practice lead to effective learning by students, it is anticipated it did so based on the literature and the experience of the researcher, but collecting student data to test this hypothesis was outside the gamut of this thesis.

What follows is a list of possible future research questions, and some brief elaborations, that might stimulate further studies in Papua New Guinea, and in other countries that might have similar language policies.

- ***What are the practices of code-switching within the teaching process that could effectively guide successful learning of unbalanced multilingual students?***

There is a need to carry out a larger scale study into the language practices of code-switching that were identified as being used by the teachers in Papua New Guinea in this small scale study. These teachers had no training in using effective code-switching strategies in the teaching process. What was occurring seemed to be practices they had learnt naturally simply because they were multilingual speakers themselves, and on the whole good teachers. Hence it may be that the skills they used in their teaching which involved code-switching may not have been the most relevant and effective to enhance communication in the classroom context. But there is no doubt the study observed good teachers who were trying their best to use their natural inclinations as a teaching resource. Therefore, there is a need to carry out a larger scale study to distinguish the practices of code-switching that are most suitable for teaching purposes, and measure these against how successfully these strategies guide the learning of students.

- ***Is there any relationship between the practices of code-switching in teaching and the fluency of students in any one of the languages involved in any particular classroom context?***

This study has helped to promote a view that the way code-switching is used in teaching, and how frequently it occurs, might have some relationship to the level of fluency the students have in any of the languages they use in their schooling. It is believed that if the teachers know the differences in fluency that students have in their languages, the teachers would respond accordingly and maybe use the language practice of code-switching in a variety of ways dependent to some degree on this knowledge. This study found that when English was introduced for the first time, the teachers in the study suggested the effective way of promoting mathematical English was through code-borrowing, while the local languages were the dominant languages of instruction. If the frequency of language use shifts as recommended by the new language policy, probably from local languages to a more dominant use of English in the later grades (4-8) of primary schooling, then the question arises as to what practices of code-switching should be promoted along with this change, and for what purposes? In this study, the way code-switching was used in grade 3 class was presumably suitable for people beginning to learn a new language, in this case mathematical English. The method used by the teachers was using local languages as a the dominate verbal communication vehicle, but frequently using code-borrowing in such a way within the grammatical rule of the sentence structure, so that terms and phrases from the English mathematics register were borrowed and were promoted. However, what practices of code-switching should be used for people who have some fluency in English is another question which could not be answered by the data collected here. Another related question arises for a slightly different context: How should code-switching be used or should it not be used in classrooms that have balanced multilingual students? These and like questions might stimulate studies to investigate when and how code-switching could be used within teaching, when aiming to guide learners with different fluency levels in the languages available, for learning in different contexts.

- ***What are more effective practices of code-switching compared to practices of code-switching which are not effective, within the teaching process?***

This question is related to the first question, but specifically targeting good practices of code-switching compared with ineffective practices of code-switching. This study uncovered some hints that not all practices of code-switching were appropriate. Since the focus of this study was not to critique effective code-switching and those practices that were not, there is little to go on. However, in this study a brief analysis was made of one teacher who appeared to be very effective in her language use in the classroom, and it was assumed she was more effective in code-switching than the other seven teachers. Her approach to code-switching was described in Chapter 6. The crucial difference that made this teacher stand out was her use of fluently-spoken local languages to engage in conceptual discourse, unlike some of the other teachers who were more inclined to use local languages for procedural discourse. This suggests it would be useful in future studies to investigate what are effective code-switching practices that can be used for conceptual discourse. On the other hand, what are ineffective code-switching practices that do not promote such discourse? In addition, is the effectiveness of code-switching and how it could be used within different language contexts that are influenced by the fluency of the students with whom the teacher is trying to effectively communicate? Hence, there is a need to investigate which practices of code-switching add to effective means of communicating for each category of students in terms of fluency of each language involved.

- ***What are the advantages and disadvantages for cognitive processes related to code-switching?***

The teachers interviewed in this study claimed that they code-switched and alternated between the local languages to help students understand and consequently learn. This was a very strong claim, but this study did not use any measures of student achievement. Therefore, there is a need to carry out a study that could consider impacts of code-switching used in teaching on student achievement and learning.

- ***When is the right moment for code-switching?***

There is a need to investigate the more advantageous moments in teaching to use the language-practice of code-switching. It is possible that not all moments of teaching would require code-switching and an alternate language for effective communication. Therefore, there is a need to investigate and identify the appropriate moments in teaching that would be enhanced by using language practices to effectively alternate languages that would lead to more effective learning. This study found that teachers chose to code-switch when they wanted to promote a mathematics term – particularly in English, to ask a question, or to give an explanation. However, there is a need to confirm this and discover more. There is a need to distinguish the suitable moments in teaching for which the language practices of code-switching could be used successfully as a teaching tool.

So far, I have discussed possible issues to be investigated related to code-switching. The new language policy of PNG also emphasized that both local languages and English should be promoted through the bridging process. This study found that, to do this, the common practice used by these teachers was code-switching. However, as indicated earlier, terms and phrases belonging to the mathematics register expressed in English were frequently used and promoted, but not those mathematical terms and phrases expressed in the local languages. Hence it appeared that the overwhelming target of verbal communication was to promote terms/phrases expressed in English. But there is a possibility that teachers found it difficult to distinguish terms/phrases embedded in the local languages as related to mathematics. To help teachers use the mathematics registers from the local languages, detailed research is needed. The following section aims to stimulate possible research questions in this area using Ethnomathematics studies.

8.6.4.2 Cultural Mathematical Ideas - Ethnomathematics

Through this study, it was found that the most popular type of code-switching was code-borrowing, where most mathematical terms or phrases expressed in English were commonly borrowed and used in sentences constructed in the local languages. As indicated earlier, the main target of mathematics discourse was to promote mathematical English, and since the local languages were commonly used for teaching, the frequency of code-borrowing was not a surprise. The teachers purposefully borrowed important mathematical terms and phrases to be learnt by students as noun phrase, embedded in a sentence constructed in a local language that became the verb phrase. This meant that the frequently-used local language was used to talk about and promote the concepts of the English mathematics register. The conclusion drawn through this case study was that since the target of teaching was to promote mathematical English, and concepts expressed in English, such terms/phrases were constantly used, but rarely were they drawn from the local language.

However, promoting only mathematical concepts expressed in English in teaching was not the only recommendation of the new language policy. The new language policy also stated that in the same process within teaching, both mathematical English and the local language should be promoted. The policy shared the same global view that all languages spoken by humans should be protected and maintained; this included the 817 languages of Papua New Guinea. In order to do this in the classroom context, the local languages should be used alongside each other, with well-developed mathematical languages, such as English.

The English language and the languages from Papua New Guinea were not developed for the same social and physical use; hence there are undoubted differences between these languages. These differences become clear when the languages are used side by side. For instance, in this case, the teacher might not easily identify some mathematical terms and phrases in the local language which more or less match those expressed in English. Interestingly some teachers that participated in this study did use some mathematical terms and phrases belonging to *Wahgi*, and they used these as a resource to help the students reflect on their understanding of what was expressed in English. However, most teachers in this study just used the English mathematical register and did not worry about using the local language in this way, because the target of teaching and learning was to promote mathematical English. This may be an easy way out, but is not doing justice to developing and maintaining the local language, which will be dying if such a trend of language use is continued.

It was possible that the teachers were not able to distinguish easily what were western (or near-western) mathematical concepts within their cultural setting, and hence they did not have the option of using what might have proved to be appropriate terms and phrases from *Wahgi*. In most cases in Papua New Guinea, cultural knowledge is not segmented in the same way as it is in western cultures, and there is little to distinguish mathematics or science ideas. That is not to say these ideas do not exist. They do, but they are subsumed within the whole culture. To isolate and identify mathematical and scientific ideas from the more holistic Papua New Guinean cultures is challenging, even if you belong to that culture and speak the language. This was the experience of Muke (2001) when trying to distinguish counting systems in his own *Wahgi* culture. To help teachers to distinguish mathematical registers in their respective cultures, there is a need for studies that could be guided by research techniques of Ethnomathematics. This could help distinguish the existing cultural knowledge and the embedded mathematical ideas, and acknowledge the absences of what is not found in comparison to mathematical ideas taught at school. It is possible that not all mathematical ideas used at school will be found in a particular cultural knowledge. Even if they are, the level and context appropriate may prove different. However, such findings will help inform the policy makers to initiate further policy change. Such a process is happening in New Zealand where, mathematical registers that do not exist are introduced and shared by academics with respective cultural groups (Barton, 1995, 1997). It is recommended that similar Ethnomathematics studies should also be conducted in PNG, not only to identify cultural mathematical ideas, but also examine how they could contribute to the education process of students from the many different cultures within Papua New Guinea. The following are some questions that could be used for any future studies:

- What are the cultural mathematical ideas that do match those of school mathematics?
- What are school mathematical ideas expressed in English that could not have an equivalent expression in the local language and culture?

- Could new mathematics registers be invented in the local language to match the mathematical ideas expressed in English?
- What are the social and educational benefits of identifying the existing and inventing new mathematical expressions in the local language that match those expressed in English?

8.4.6.3 Impacts of Using Pidgin in Teaching and Learning Mathematical English

This section aims to suggest that a detailed study is needed to be carried out to understand the impacts of using *Pidgin* for both teaching and learning. The impacts could be both positive and negative. As linguistic might describe, *Pidgin* is a *lingua franca* and was created due to an influence by other powerful languages such as English in the colonial times. In most cases, they are regarded as broken English. It is evident through the sounds and words used that they are mostly from English background. However, the grammatical structure is completely different. Such a background could have both positive and negative impacts on cognition process, when used to teach and learn mathematics. As indicated in this study, the aim of using *Pidgin* was to act as a teaching resource to introduce mathematical English and mathematical content. Since *Pidgin* shares historical background with English, but has a questionable grammatical structure, there is a need for detailed study to understand the impacts of *Pidgin* in both teaching and learning mathematics English.

8.7 Summary

To sum up this thesis, this study has shown that the part of the 1992 new language policy in Papua New Guinea that recommended the ‘bridging processes’ was implemented by the eight teachers that participated in this study. The language-practice that enabled the success of the ‘bridging process’, which required the use of the local language as a resource to introduce English in the same conversation, was ‘code-switching’. The main reason teachers in this study used code-switching was to guide the effective learning of mathematical English, particularly for the unbalanced multilingual students who were meeting English for the first time. The role the local languages played as a resource to contribute to this purpose of code-switching was to help students understand meanings of mathematics registers, and thus guide effective learning of mathematical English and related mathematics concepts.

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APPENDIX A: ETHICS APPROVAL LETTER

Australian Catholic University
Brisbane Sydney Canberra Ballarat Melbourne

ACU National

Human Research Ethics Committee

<u>Committee Approval Form</u>

Principal Investigator/Supervisor: A/P Phil Clarkson Melbourne Campus
Co-Investigators: Dr Andrea McDonough Melbourne Campus
Student Researcher: Mr Charly Muke Melbourne Campus

Ethics approval has been granted for the following project: The role of the local language in teaching mathematics at the bridging class (Grade 3) in Papua New Guinea
for the period: 04/03/05 - 31/12/05
Human Research Ethics Committee (HREC) Register Number: V2004.05-36

The following <u>standard</u> conditions as stipulated in the *National Statement on Ethical Conduct in Research Involving Humans* (1999) apply:

(i) that Principal Investigators / Supervisors provide, on the form supplied by the Human Research Ethics Committee, annual reports on matters such as:
- security of records
- compliance with approved consent procedures and documentation
- compliance with special conditions, and

(ii) that researchers report to the HREC immediately any matter that might affect the ethical acceptability of the protocol, such as:
- proposed changes to the protocol
- unforeseen circumstances or events
- adverse effects on participants

The HREC will conduct an audit each year of all projects deemed to be of more than minimum risk. There will also be random audits of a sample of projects considered to be of minimum risk on all campuses each year.

Within one month of the conclusion of the project, researchers are required to complete a *Final Report Form* and submit it to the local Research Services Officer.

If the project continues for more than one year, researchers are required to complete an *Annual Progress Report Form* and submit it to the local Research Services Officer within one month of the anniversary date of the ethics approval.

Signed: .... Date: 04/03/05
(Research Services Officer, Melbourne Campus)

(Committee Approval.dot @ 15/10/04) Page 1 of 1

res ethics
Sent by: Jo Mushin
15/02/2006 04:02 PM

To: Philip Clarkson/patrick@patrick, charly_muke@yahoo.com.au, ccmuke001@student.patrick.acu.edu.au
cc:
Subject: Approval of Ethics Extension V200405 36

Dear Phil and Charly,

Thank you for returning the Progress Report for your ethics application V200405 36 *The role of the local language in teaching mathematics at the bridging class (grade 3) in Papua New Guinea.*

The Chair of the Human Research Ethics Committee has approved your request to extend the period of data collection.

The new expiry date for data collection is **31st December 2006.**

At the end of this period you will be required to complete a progress report. You can either obtain this from the ACU National website www.acu.edu.au , or by contacting Research Services directly.

We wish you well with the continuation of your research.

Kind regards

Jo

****

Jo Mushin
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CRICOS provider registration codes: 0004G, 00112C, 00873F, 00885B

APPENDIX B: QUESTIONNAIRES

Preliminary Study
Questionnaire

This questionnaire is to be filled by teachers currently teaching at the Primary Schools. Please, make an attempt to answer all questions.

A. Personal Information

1. Name:
2. Male/Female
3. Age:
4. Home Province:
5. Home District:
6. Village:
7. Tribe:

B. Cultural and Language Background

8. How many languages do you use for communication purposes?

   (*These languages should include any languages that you can hear and understand but could not respond to verbally).*

9. List these languages in the space provided.

1.	2.
3.	4.

10. What is the name of your local language that members of your tribe use to communicate?

11. Are you able to speak your local language that most of your tribe members speak?

    Yes ☐ No ☐

12. What is/are the language(s) you use with your family, especially with your children.

1.	2.
3.	4.

13. Which language(s) do you think are important for your own children to speak in relation to schooling? Why?

14. Education, Teachers Training and Work Background

15. What is the name of the Primary School you are currently teaching in?

16. Which Grade are you teaching in this year?

17. How many years have you taught as Community or Primary School teacher?

18. List the grades you taught in over the last ten years.

Year(s)	**Grade**
2004	________
2003	________
2002	________
2001	________
2000	________
1999	________
1998	________
1997	________

19. Which Community/Primary Teachers' College did you attend for your training?

20. What year did you attend this training?

21. Were you trained to teach 'Bridging Class' (Grade 3) during your teacher training?

Yes No

22. Did you attend any in-service course that related to teaching Bridging Class?

Yes No

23. If ' Yes' for question 20, describe this in-service program and how it helped or did not help you. If 'No' for question 20, then go straight onto question 22.

24. Language of Instruction

25. In your current teaching this year (2005), across all your teaching, how many languages in total do you think you are using in the classroom?

26. Name these different languages you use in your teaching?

27. How often do you use the local language that is used by the surrounding community of the school you are currently teaching?

Not at all ☐ a little ☐ most times ☐

Why? ______________________________________

____

____

28. How often do you use Pidgin in your teaching?

Not at all ☐ a little ☐ most times ☐

Why? ______________________________________

____

____

29. How often do you use English in your teaching?

Not at all ☐ a little ☐ most times ☐

Why? ______________________________________

____

____

30. In particular, what languages do you use when teaching mathematics?

APPENDIX C: CHAPTER FIVE

Appendix C: 5.1: Number of Languages per Lesson

Teachers	Lesson	Languages Used for Teaching		
		1	**2**	3
K	1	Wahgi	Pidgin	English
	2	Wahgi	Pidgin	English
	3		Pidgin	English
W	1		Pidgin	English
	2	Wahgi	Pidgin	English
	3	Wahgi	Pidgin	English
D	1	Wahgi	Pidgin	English
	2	Wahgi	Pidgin	English
B	1	Wahgi	Pidgin	English
M	1	Wahgi	Pidgin	*
	2	Wahgi	Pidgin	English
	3	Wahgi	Pidgin	English
J	1	Wahgi	Pidgin	English
	2	Wahgi	Pidgin	English
T	1	Wahgi	Pidgin	English
A	1	Wahgi	Pidgin	English

*Borrowed Formal Mathematical English Terms/Phrase were not considered.

Appendix C: 5.2: Frequency of Using Each Language Per Lesson

Teacher/Lesson		Percentage (%) of Language Use			Total (%)
Teacher	**Lesson No.**	**Wahgi**	**Pidgin**	**English**	
K	**1**	3	54	31	**88**
	2	13	75	5	**93**
	3	0	32	61	**93**
W	**1**	0	41	48	**90**
	2	2	75	16	**93**
	3	6	69	20	**94**
D	**1**	12	55	27	**94**
	2	17	63	12	**93**
GK	**1**	46	5	43	**94**
M	**1**	57	25	0	**82**
	2	16	65	11	**93**
	3	53	43	1	**97**
J	**1**	24	69	2	**95**
	2	8	76	5	**88**
T	**1**	17	74	2	**93**
A	**1**	7	9	80	**96**
Average	***16***	***17.6%***	***51.9%***	***22.8%***	***92.3%***

Note: The totals do not add to 100%. The difference was talk by children.

Appendix C: 5.3: Language Combination –Leading and Supportive Languages

Leading Language	First/Second Supportive Language	No. Less.	Amount of Language in Each Combination Per Lesson			
Pidgin	Wahgi/English	6	***Lesson***	***Pidgin***	***Wahgi***	***English***
			M2	65%	16%	11%
			D2	63%	17%	12%
			J1	69%	24%	2%
			J2	76%	8%	5%
			T1	74%	17%	2%
			K2	75%	13%	5%
	English/Wahgi	4	***Lesson***	***Pidgin***	***English***	***Wahgi***
			K1	54%	31%	3%
			W2	75%	16%	2%
			W3	69%	20%	6%
			D1	55%	27%	12%
Wahgi	Pidgin /English	2	***Lesson***	***Wahgi***	***Pidgin***	***English***
			M1	57%	25%	0%*
			M3	53%	43%	1%
	English/Pidgin	1	***Lesson***	***Wahgi***	***English***	***Pidgin***
			B1	46%	43%	5%
English	Pidgin/Wahgi	3	***Lesson***	***English***	***Pidgin***	***Wahgi***
			A1	80%	9%	7%
			K3	61%	32%	0%
			W1	48%	41%	0%
	Wahgi/Pidgin	0	***None of the teachers used this order – English/Wahgi/Pidgin***			

***code-borrowing/Code-mixing English terms/phrase was not counted.**
**** M2 refers to 'Teacher M, second lesson'.**

Appendix C: 5.4: The Count of Switching Language Per Lesson

Lesson	Number of Switch to			Total Switch	Word Count Percentage		
	Wahgi	Pidgin	Englis		Wahg	Pidgin	English
K1	9	37	28	74	**3**	**54**	**31**
K2	9	**24**	**21**	**54**	13	75	5
K3	0	**13**	**14**	**27**	0	32	61
W1	0	**16**	**16**	**32**	0	41	48
W2	3	**23**	**22**	**48**	2	75	16
W3	4	**29**	**28**	**61**	6	69	20
D1	28	64	55	147	**12**	**55**	**27**
D2	3	**23**	**22**	**48**	17	63	12
KB1	**33**	14	**35**	**82**	46	5	43
M1	**8**	**6**	2	16	57	25	5
M2	4	**24**	**21**	**49**	16	65	11
M3	**8**	**9**	3	20	53	43	1
J1	**51**	**59**	12	122	24	69	2
J2	20	28	14	62	8	76	5
T1	12	21	9	42	17	74	2
A1	10	**22**	**27**	**59**	7	9	80

Note: Switching does not include code-borrowing and code mixing

Appendix C: 5.5: Mathematics Registers Expressed in English Borrowed for Sentence Constructed in the Local Languages; Wahgi & Pidgin

No	Lesson	Lesson Topics	Borrowed Formal Mathematical English Terms by two Local	
			Wahgi	Pidgin
1	K1	Addition	(number names, eg. 1, 2, 30, 100)	plus, equals, carry, put down, addition, number (place value names) (number
2	K2	Measuring Distance	Guess, measurement, meter,	measurement, millimeters, centimeters, meters, kilometers, 10mm = 1c, 100cm =
3	K3	Division		- division, times, divided, count, …group of …, equals, (numbers names)
4	W1	Writing number in Words & Picture		number chart, numbers, words, objects, (number names)
5	W2	Fraction		- fraction, one whole, parts, half, one half, one fourth, two thirds, three fourths, one
6	W3	Shapes & Angles	Shapes, corner	- shapes, kite, corner, rectangle, measurement, triangle, square, oblong,
7	D1	Weight	weight	- measurement, weight, grams, kilograms [number names]
8	D2	Perimeter	Perimeter, meters, (number names)	- perimeter, shapes, meters, centimetres, number, [number names]
9	B1		measurement, weight, length, units, grams,	milligrams,
10	M1	Multiplication & Division	Multiplication, times, times table, group.	times table, multiplication, division, number, (number names)
11	M2	Multiples	- multiples of 5, multiples of 4,	- multiplication, multiples, equals, number, multiply, divide, takeaway, [(a x
12	M3	Fraction	Half, quarters, one	whole, half, quarter, (number names)
13	J1	Multiplication: 2 Numbers x 2	Plus, subtract, number, times, a	- times, plus, subtract, multiplication, place value, carry, put down, groups of, [
14	J2	Multiplication: 1 number with 3	Plus, carry, (number names)	- plus, place value, takeaway, a groups of b, put down, carry, zero, [(names of place
15	T1	Word Problem: Add	- plus, (number	- takeaway, plus, all together [number
16	A1	Fraction & Shapes	- quarter,	-fractions, square,

APPENDIX D: CHAPTER 6

Appendix D: 6.1. Language Used by Teachers within Lesson Phases

Teachers	Lesson	Introduction (%)			Body (%)						Conclusion (%)		
					Content Teaching			**Content Practice**					
		W	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**
K	**1**	0	2	11	0	33	2	0	11	13	0	17	5
	2	0	8	1	9	31	1	4	17	2	1	15	2
	3	0	0	7	0	31	15	0	3	30	0	0	13
W	**1**	0	0	3	0	42	43	0	0	0	0	0	0
	2	0	23	3	0	4	4	4	3	1	2	17	7
	3	0	7	2	1	31	6	6	1	10	2	26	2
M	**1**	20	4	0	49	27	0	0	0	0	0	0	0
	2	0	6	0	51	36	0	4	2	0	0	0	0
	3	0	4	1	17	24	5	0	34	4	0	9	0
D	**1**	0	3	4	1	12	2	5	24	4	6	20	18
	2	0	0	0	5	26	6	14	42	7	0	0	0
J	**1**	1	4	0	4	31	20	20	38	1	0	0	0
	2	0	10	0	3	19	2	0	34	2	5	23	1
GK	**1**	5	0	3	16	5	15	28	1	28	0	0	0
T	**1**	2	5	0	3	26	1	13	31	1	0	8	0
A	**1**	0	0	22	7	4	25	0	1	11	0	5	25
	Average	1.9%	4.75	3.56	10.38	23.88	9.19	6.13	15.13	7.13	1%	8.75	4.56

Key: **W = Wahgi, P = Pidgin, E = English, 0 = language used but not significant against the proportion of the total words count of the lesson.**

Appendix D: 6.2. Purposes of Talking at the Introduction

Teacher	Lesson Date	Purpose At the Introduction	Language
K	05/05/2005	• Greetings • **Introducing lesson topic – Addition** • **Defining Addition** • Revision (spelling number names) • Classroom Control	English English Pidgin/Wahgi English English
	07/06/2006	• Introducing lesson topic • Revision (units of measurement –length) • Classroom Control	Pidgin Pidgin English
	19/04/07	• Greetings • Revision (saying 2 times Table) • Classroom control	English English English
W	21/03/06	• Introducing lesson topic • Making students read the lesson topic correctly • Classroom control	English English English
	22/03/06	• Describing realistic context at home related to sharing. • Introducing the lesson topic • Asking students if their experienced this word before. • Spelling the term Fraction • Defining Fraction • Classroom control	Pidgin English Pidgin English English/Pidgin English
	22/08/06	• Classroom control • Introducing lesson topic • Revision/Explaining (Describing Shapes)	English English English/Pidgin/Wahgi
D	06/05/05	• Greetings • Introducing lesson topic – measurement (weight) • Checking if they had brought objects for class use • Classroom control	English English Pidgin English
	24/10/2005	• Introducing lesson topic - Perimeter	English
GK	08/05/05	• Greetings • Introducing lesson topic	English English/Pidgin
M	20/03/06	• Asking students to speak aloud for recording • Revisions (2, 3 & 5 times Table) • Classroom control	Wahgi English/Wahgi Wahgi
	21/03/06	• Greetings • Introducing lesson topic • Revision (quiz – times table) • Classroom control	English English English Pidgin
	28/08/06	• Introducing context about cutting from home • Revision - Naming fruits that could be cut • Classroom control	Pidgin Pidgin Pidgin
J	20/03/06	• Revision	Pidgin/Wahgi
	21/03/2006	• Classroom control • Introducing lesson topic - Multiplication • Revision – 2 times table • Describing what they did last week and how they did multiplication.	English Pidgin English Pidgin
T	27/05/05	• Realistic context (naming animals in the bush for hunting) • Classroom Control	Pidgin/Wahgi
A	25/10/05	• Introducing lesson topic – Fraction • Revision – names of shapes and asking how many colored • Classroom control	English English English

Appendix D: 6.3. Language Emphasis in Lesson Phases

Teachers	Lesson	Introduction (%)			Body (%)						Conclusion (%)		
					Content Teaching			**Content Practice**					
		W	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**	**W**	**P**	**E**
K	**1**	0	2	26	0	33	2	0	11	13	0	17	5
	2	0	8	1	9	31	1	4	17	2	1	15	2
	3	0	0	7	0	31	15	0	3	30	0	0	13
W	**1**	0	23	3	0	4	4	4	3	1	2	17	7
	2	o	0	7	0	46	47	0	0	0	0	0	0
	3	0	7	2	1	31	6	6	1	21	2	26	2
M	**1**	20	4	0	49	27	0	0	0	0	0	0	0
	2	0	6	0	51	36	0	4	2	0	0	0	0
	3	0	4	4	17	24	5	0	34	4	0	9	0
D	**1**	0	3	4	1	12	2	5	24	4	6	20	18
	2	0	0	0	5	26	6	14	42	7	0	0	0
J	**1**	1	4	0	4	31	20	20	38	1	0	0	0
	2	0	10	0	3	19	2	0	34	2	5	23	1
KB	**1**	5	0	3	16	5	15	28	1	28	0	0	0
T	**1**	2	5	0	3	26	1	13	31	1	0	8	0
A	**1**	0	0	22	7	4	25	0	1	11	0	5	25
Total		**1.75**	**4.75**	**4.9**	**10.3**	**23.75**	**9.4**	**6.1**	**15.1**	**7.8**	**1**	**8.7**	**4.5**

Key: **W = Wahgi, P = Pidgin, E = English, 0 = language used but not significant against the proportion of the total words count of the lesson.**