ABSTRACT

The widespread use of English has led, in some countries, to content areas such as mathematics being taught in English, when English is not the mother tongue of either the teachers or the students. The main focus of this study was on education practices in Malaysia where teachers had to teach mathematics in English to students who are still learning the language. The teachers being second language users themselves have to acquire sufficient English language skills in order to teach effectively. The fact that mathematics has its own language, known as mathematics register, complicates the situation as mastery of mathematics register is essential for mathematics learning to take place. Mathematics teachers need to be able to use mathematics register as well as promote its usage among students. This is especially crucial in a second language situation where students rely heavily on the teachers for language input and modelling in a second language. In order to examine the language mathematics teachers used, classroom observations were conducted in two primary schools in Malaysia. These observations were followed by stimulated recall sessions with the teachers. The findings showed procedural discourse tended to dominate the lessons because of teacher-centred classroom activities and that the first language, Bahasa Malaysia, was used mostly in conceptual discourse to ensure students' understanding. In addition, it was found that teachers realised the obligation to provide language input to the students, hence, English was used for most of the lessons. However, the occurrence of language errors indicated that teachers still need more training in order to be able to teach in English. The findings of this research suggested that teaching of mathematics can be done in a second language provided teachers are equipped with appropriate language-related strategies.

ACKNOWLEDGEMENTS

What a long journey this has been

Full of twists and turns

Travelled hard travel well

Without shortcuts

A journey worth taking

Just because you are not alone

First and foremost I offer my sincerest gratitude to my supervisor, Dr Mary Simpson, who has supported me throughout my thesis with her patience and knowledge. I am fortunate to have an advisor who gave me freedom to discover knowledge on my own and at the same time made sure I am on the right track, making me what I am today.

I am grateful to my other supervisor Dr Sarah Stein who never stopped encouraging and giving her full support. Her guidance and motivation was priceless. A special acknowledgement also to Julie Farquhar, for taking good care of us, post grad students. My fellow friends who are doing their PhD and Master (Julie, Barry, Kelly, Hung, Lee & Lara); I wish you all the best in whatever you are doing. I am also thankful to the following staff in the College of Education; David, Greg, Karen, Ross and Keryn who are all wonderful people.

Finally to the love of my life, my wife, Nik Nurlaili, my children Amirah, Aisyah, Amni, Nazme and Aryana, you are my inspiration.

And thanks to all friends I have made along the way.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ELLS	English Language Limited Speakers
ETeMS	English for Teaching of Mathematics and Science
ERIC	Educational Resources Information Catalogue
MERGA	Mathematics Education Research Group of Australasia
TEFL	Teaching English as a Foreign Language
MRA	The Model of Mathematics Register Acquisition
BICS	Basic Interpersonal Communication Skills
CALP	Cognitive Academic Language Proficiency
L1	First Language
L2	Second Language
FDE	Further Diploma in Education
LoLT	Language of Learning and Teaching
IPG	Institutes of Teachers' Education
UPSR	Primary School Assessment
MDG	Millennium Development Goals
TESOL	Teaching English to Speakers of Other Languages
EPU	Economic Planning Unit
SLA	Second Language Acquisition

CHAPTER ONE

INTRODUCTION

Among impacts of globalisation is the widespread use of English in many parts of the world. In the field of education, the emergence of English as a global language has influenced language planning and policy-making in many countries especially in the Asia-Pacific region (Ho, 2002; Nunan, 2003). An example of this is the use of English as the medium of instruction for subjects related to the field of mathematics, science and technology. This research investigated the use of English by mathematics teachers who were teaching in primary schools in Malaysia, where English is the second language for both the teachers and students.

As a former British colony, formal education in Malaysia started in English (Gaudart, 1987). At the beginning of 1970, the medium of instruction in Malaysian schools was changed to the national language, Bahasa Malaysia. From that point, English was taught as a second language. However, in 2003, English was reinstated as the medium of instruction for teaching mathematics and science in Malaysian schools. While this move was felt necessary by the Malaysian government to prepare the students to become competitive in this globalisation era, many people including academics and parents, felt that it was too drastic (Abdullah & Heng, 2003; Ibrahim, 2007). There was also great concern over the students' low level of proficiency in English and their ability to cope with learning two subjects, mathematics and science in a second language (Heng & Tan, 2006). In 2010, the medium of instruction for teaching of science and

mathematics reverted to Bahasa Malaysia due to pressure to preserve national identity and unity. This move, however, does not render this research as insignificant. Given that education policy in regard to language of instruction for mathematics keeps changing in Malaysia, it is clear that the issue of which language is used in teaching is significant in Malaysian education. Therefore, this research is useful for teachers in Malaysia to make, "an informed decision and perform an appropriate role in supporting bilingualism in a changing classroom setting" (Mohamed, Nordin & Hashim, 2007, p. 446).

This study examined mathematics teachers' use of English as the language of instruction in two Malaysian primary schools. The focus of the study was on issues surrounding the teachers' use of instructional language where mathematics was taught in English, the second language of the teachers as well as the students.

This chapter begins by presenting the language contexts for teaching of mathematics in a second language which includes the multilingual contexts for learning mathematics as well as the Malaysian context for teaching of mathematics in English. Discussion of language context is important as it is the main focus for this research.

1.1. Language Contexts for Teaching of Mathematics.

Acquiring the language of mathematics or mathematics register has been shown to be a critical aspect of learning mathematics (Cuevas, 1984) and learning of mathematics register can be problematic to both native and non-native speakers. While learners who are native speakers may have problems with understanding mathematics concepts, second language learners often struggle, learning both the English language and mathematics register in English (Garegae, 2003). Teachers play an important role in mathematics

teaching especially in second language classrooms, where students rely heavily on their teachers for language support. Meaney (2006) stated that teachers not only need to help students to acquire mathematics register but they also have an obligation to provide the students with the opportunity to use these newly acquired expressions. A study by Khisty and Chval (2002) lent support to this statement. They found that second language students were likely to 'mirror' the language used by their teachers. Their study suggested that teachers' use of language had a significant impact on students' learning of mathematics register. Thus, a study into the teachers' discursive practice might be useful to provide insights into the kind of strategies that could be helpful in teaching mathematics to second language learners.

The relationship between language and mathematics becomes even more complex with the presence of students from different races, with different cultures and languages, in the same classroom. In a multilingual classroom, there is a need for a common language, which everyone can understand. English, which is considered a global language by many developed countries because it is widely used in many important fields including science and technology, is the language of education in many countries. Clarkson (2004) stated that multilingualism "brings challenges for pedagogical tradition of teaching, including mathematics teaching" (p. 13).

The purpose of this study was to look into mathematics teachers' use of language in two multilingual primary schools in order to gain in-depth understanding of teaching mathematics in a second language. In the next section, different multilingual contexts for teaching mathematics in a second language will be presented. Then the specific situation in Malaysia will be discussed.

1.1.1. Multilingual contexts in teaching mathematics.

This section explores the different language environments present in multilingual contexts, for teaching mathematics. As pointed out earlier, multilingual contexts in education vary from one another. To further illustrate these different contexts, it is important to understand the processes that lead to multilingualism in education.

There are a number of factors which have contributed to the emergence of multilingual education contexts. In developed nations like the United States of America, Australia and the United Kingdom, the increase in migration of people from other countries has brought different languages and cultures into the host countries. Examples of this situation are the presence of Latino students in the United States of America (Khisty & Chval, 2002; Moschkovich, 2002) and Vietnamese students in Australia (Clarkson, 2004). Barwell, Barton, & Setati (2007) noted that approximately 500,000 students in the United Kingdom are speakers of English as a second language. It is not surprising that teachers in these developed countries might be finding more and more students in their classrooms than ever before who do not share the same native language with them or the other English-speaking students. This is the context where monolingual teachers are teaching a mixture of monolingual and multilingual migrant students. Another common situation in Western countries is when a teacher, who is a native speaker of English, is teaching a class where most students are second language speakers as in the case of a Caucasian teacher teaching a class of Hispanic students, as cited in Khisty's (2000) study.

Another context for multilingual classrooms comes about as a result of education policies. Many countries in the world view English as the necessary and neutral choice for the language of instruction in schools (Barwell et al., 2007). In countries like South Africa and Papua New Guinea, where a range of languages is used by different linguistic groups, a *neutral* language like English is chosen as the language of instruction (Clarkson & Galbraith, 1992; Setati, 2005). English is often associated with power and status and, because of this, Setati (2008) found most parents in South Africa preferred their children to be educated in English. In the situation described by Setati (2008), the language of instruction was neither that of the teachers nor the students. This is an example of a situation where a multilingual teacher was teaching multilingual students using a language that was not the first language of the teacher or of the students. The contexts described above can be summarised as follows:

- Monolingual teachers teaching a mixture of monolingual and multilingual migrant students (e.g. urban schools in Australia).
- Monolingual teachers teaching multilingual students all speaking the same language (e.g. Caucasian teachers teaching Hispanic students in the United States of America).
- Multilingual teachers teaching multilingual students using a language of instruction that is not the first language of the teachers or the students (e.g. Papua New Guinea). (Clarkson, 2004)

These multilingual contexts for teaching mathematics have several implications for research in this field. Clarkson (2004) highlighted these implications in his review of research literature in teaching mathematics. First, he explained that the different multilingual contexts were often overlooked by researchers. These contexts were often treated as a single context when in fact each of them is unique and worth investigating. Clarkson proposed that the different multilingual contexts should become important variables for future research.

The second point Clarkson (2004) raised was related to the fact that mathematics deals with abstract concepts, which are communicated through language. The presence of multilingual students could have some effects on communication in the mathematics classroom. It is, therefore, important to investigate the impact of this heterogeneity on the free flow of mathematics ideas in multilingual classrooms.

The next point Clarkson made was in relation to his review of four journals on research in mathematics education from 2000 to 2003, namely, *Journal in Mathematics Education, Educational Studies in Mathematics, For the Learning of Mathematics,* and *Mathematics Education Research Journal*. From approximately 300 articles, he found that very few were dedicated to the teacher's role in multilingual classrooms. Rather, they focused on the learners and the issues in learning of mathematics in a second language. He concluded that more research was needed to clarify the role that the teachers play in such situations, as their role is pivotal in helping the students to be competent in mathematics.

As stated earlier, each multilingual context is unique and it is only logical that research carried out in different contexts covers different issues of concern. For example, while researchers in developed countries like the United States of America are concerned with the education of the minority groups (Khisty & Chval, 2002), researchers in South Africa and Asia examine the use of certain teaching strategies by teachers including code switching in teaching and learning mathematics (Setati & Adler, 2000).

Current shifts in mathematics curriculum which emphasise communication have also influenced research in this field. Early studies in multilingualism focused on challenges faced by students in terms of solving word problems and understanding vocabulary (Adetula, 1985). The focus now has shifted to students' construction of knowledge through participation in mathematical communication (Moschkovich, 2002). Among others, Moschkovich suggested that bilingualism should not be seen as a problem; rather it should be considered as one of the resources students could draw upon in the learning process. On the other hand, Barwell et al. (2007) argued that teaching mathematics in a language the students were still learning, such as in the situation in Malaysia, could be problematic especially to the students. Students experience difficulties understanding mathematics concepts and how they are applied as well as difficulties understanding the language in which the concepts are embedded. The teachers have a dual task of teaching mathematics and using a second language simultaneously. In this situation, teachers may focus on their fluency rather than on the mathematics learning taking place. More discussion on this issue is presented in Chapter Two.

Having presented the different multilingual contexts for teaching mathematics, the next discussion will be on the specific context for teaching mathematics in a second language in Malaysia.

1.1.2. The multilingual context for teaching mathematics in Malaysia.

The linguistic situation in Malaysia is quite different from the contexts described in section 1.1.1. The people in Malaysia speak different first languages depending on their races. The main language is Malay; the others are variants of Chinese like Cantonese or Hokkien, Tamil and languages spoken by indigenous people (Gaudart, 1996). The official language in Malaysia is Bahasa Malaysia, which is also the official teaching language. Bahasa Malaysia is the lingua franca or the common language of communication among the different races in this country. It is a standardized form of Malay language. While Bahasa Malaysia is widely used by most people in Malaysia, in some parts of the country, especially in the cities, English is the language of communication (David, 2004). This is especially true for the Chinese and Indians whose first languages are not Malay. The terms *bilingual* and *multilingual* are used interchangeably because some people in Malaysia are bilinguals who can speak in Bahasa Malaysia and English. Others are multilingual, for example those who can speak Bahasa Malaysia, English and Cantonese. For the purpose of the research reported in this thesis, the context for teaching and learning mathematics in Malaysia is a second language context since the status of English in Malaysia is as a second language.

Based on the description above, the situation in Malaysia is that of multilingual teachers teaching multilingual students using a second language. The

teachers and students can be of different races, including Malay, Chinese or Indian who speak Malay, Chinese or Tamil respectively as their first language. However, the teacher shares a common language with the students, which is Bahasa Malaysia, the official teaching language. With the change of policy implemented in 2003, English was used as the language of instruction for teaching of mathematics and science. In a way, the language context for teaching mathematics in Malaysia is similar to that of Papua New Guinea where the language of instruction is a second language for both teacher and students. However, with the use of Bahasa Malaysia, the official language, as the medium of instruction for teaching other subjects, the situation in Malaysia presents yet another category of multilingual context. The linguistics complexity of the multilingual context for teaching mathematics in Malaysia is illustrated in Table 1.1.

Table 1.1:
Languages Used in the Teaching Context for Mathematics in Malaysia. (Adapted from Clarkson, 2004, p.14).

	Languages						
	Official Teaching Language	Lingua franca	Language of Teaching for Maths	Student's First Language	Student's Second Language	Teacher's First Language	Teacher's Second Language
Student	Bahasa Malaysia	Bahasa Malaysia	English	Malay Chinese Indian Others	English Malay		
Teacher	Bahasa Malaysia	Bahasa Malaysia	English			Malay Chinese Indian Others	English Malay

1.2. The Significance of the Research.

When this research was undertaken in 2007, the implementation of the change of policy to teach mathematics in English was in its initial stage, therefore, not many studies had been carried out in this area. This research was conducted to fill this gap in the research literature. It has been noted that the policy change certainly suggested the need for more research in order that the effect of multilingualism on the teaching and learning process in Malaysia is better understood by educators (Mohamed et al., 2007).

> The greatest dilemma of the Malaysian education system has been its inability to understand the ethno linguistic complexity of bilingual education and its impact on students, classrooms and society in such a way as to enable teachers and instructors to make informed decisions about practice in classroom settings (p. 446).

In general, the research was carried out to investigate one of the multilingual contexts for teaching mathematics in a second language suggested by Clarkson (2004). The use of English as a medium of instruction in a country where English is not the first language, such as the case of Malaysia, adds to the complexity of the language environment in mathematics classrooms. Clarkson (2004) stated that, "In fact, this situation has interesting ramifications for teachers of mathematics" (p. 4). Thus, this research is not only useful for the Malaysian context but also for other multilingual contexts of mathematics teaching.

1.3. Research Questions.

Based on the issues that were raised in the earlier discussion, this study was set up to seek further understanding of the practice of teaching of mathematics in a second language. The focus for the study was on the discourse characteristics of mathematics teachers who were teaching in their second language. The objective of this study was to examine teachers' discourse patterns that were evident in their interactions with their students in the classroom to better understand factors that promote the learning of mathematics by students whose first language is not the language of instruction. As a result, this study proposed to answer the following questions:

1. What is the nature of the use of mathematics register by teachers in teaching mathematics in English?
2. How do the teachers explain mathematics concepts and develop them in their lessons using second language instruction?

3. Do the teachers use specific teaching strategies in teaching mathematics? If they do, when does this occur?

This study contributes to the field of teaching mathematics in multilingual contexts by identifying teaching strategies that the teachers find to be useful in teaching mathematics to students whose mother tongue is not English.

1.4. Summary and Structure of the Thesis.

The study reported in this thesis investigated the mathematics discourse practice of four Malaysian mathematics teachers. This thesis consists of eight chapters. In this chapter, Chapter One, the language context for the teaching of mathematics was discussed. This presents the background for this research.

Chapter Two, the literature review chapter, discusses the role of language in the teaching and learning of mathematics, particularly in a second language situation. The focus is on the teachers' classroom discourse practice and strategies related to it. A number of second language acquisition theories are discussed, especially in relation to the acquisition of specific mathematics register and how teachers can promote this acquisition in mathematics lessons.

Chapter Three provides information on the Malaysian education system as the backdrop for the research. The use of English and change in language policy is presented. Finally the issue of teacher training is addressed with specific reference to the effectiveness of the English for Teaching of Mathematics and Science (ETeMS) training programme implemented in Malaysia to prepare the teachers to teach mathematics in English.

Chapter Four, the methodology chapter, explains the nature of the research approach chosen, various aspects of data collection, the procedures, ethical and validity issues and the methods used in analysing the data that were gathered.

Chapter Five, the findings chapter, presents and elaborates on the data, according to the constructs, namely, four types of classroom discourse, procedural, conceptual, contextual and regulatory. The nature of use of mathematics register, and the development of mathematics register by the teachers are also discussed. Some of the teaching strategies used by the teachers during the observation are also presented in this chapter.

Chapter Six elaborates further on the findings of this research with specific focus on language issues. The practice of using code-switching and code-mixing by the teachers is discussed, together with the errors made by the teachers in using their second language to teach mathematics.

Chapter Seven, the discussion chapter, discusses the significance of the findings, comparing them with the findings available in the literature and returns to the research questions that guided this work.

Lastly, Chapter Eight considers the theoretical, research and pedagogical implications that can be drawn from the study, and recommendations for further research are made.

CHAPTER TWO

TEACHING MATHEMATICS in a SECOND LANGUAGE

2.0. Introduction.

The description of different multilingual settings for teaching mathematics in Chapter One indicates the complexity of the issue of teaching mathematics in a second language, which is the issue investigated by this study. A review of relevant literature and research studies carried out in this area is now presented. Before presenting the literature and research studies that underpin this study, the search method employed for the literature review is discussed.

2.1. Search Method.

In preparing this review, a range of databases was searched including JStor, Educational Resources (ERIC), Academic Search Complete, Pro Quest 5000, and Google Scholar for articles on the topic of teaching mathematics in a second language. In looking for the articles, the following descriptors were used: mathematics education, second language teaching, mathematics teaching and learning for second language learners, and multilingualism. Among the journals used for this review were: *Journal of Mathematics Teaching, Educational Studies in Mathematics, For the Learning of Mathematics* and *Review of Research Journals*. The bibliographies provided in each article were also searched for additional sources, which included books. In addition, conference

proceedings from the Conference of Mathematics Education Research Group of Australasia (MERGA), Teaching English as a Foreign Language Conference (TEFL), English for Teaching of Mathematics and Science Conference (ETeMS) and the International Conference on Science and Mathematics Education, University of Malaya, Malaysia were consulted. Since there were many studies conducted in the area of teaching mathematics in a second language, not all studies were included in this review. However, the studies were chosen to represent similar studies on the same issue. Review parameters were set in order to choose only materials relevant for this study. The review parameters are described below.

Initially, the year 1990 was chosen as the cut-off point. However, most articles that dealt with second language acquisition theories were dated earlier. Since these theories provide important background for the research, these articles were included. The 1990 cut-off point however, remained constant for other studies cited in this review.

The aim of this study was to examine mathematics teachers' use of language in teaching mathematics in a second language. The two aspects under investigation were the teachers' discourse patterns and teaching strategies derived from the analysis of these patterns. This review focused on studies on these two aspects. The works of Moschkovich (2002, 2003, 2005, 2007) were important as they provided an extensive review of research on mathematics discourse in multilingual contexts and have been cited by several other researchers, for example Kasule and Mapolelo (2005) and Setati (2005).

Another criterion that was used as a review parameter was the research setting. Since this research was conducted in Malaysia, most of the studies chosen for this review were carried out in similar settings, for example, South Africa and Papua New Guinea.

However, relatively few studies carried out in those settings focused on teachers' discourse practices. In order to provide the fullest picture of the issue being investigated, some research studies, which were carried out in developed countries like the United States of America, New Zealand and Australia, were also chosen.

This literature review begins with the discussion of the relationship between language and mathematics education. Then, mathematics register is discussed together with the theories of mathematics register acquisition. Finally, studies in teaching of mathematics in a second language are presented.

2.2. Language in Mathematics Education.

In this section, the relationship between language and mathematics is established through discussion of the role that language plays in the teaching and learning of mathematics.

Mathematics is an important subject in the education systems of many countries as Atweh and Clarkson (2002) observed: "The status of mathematics in the curriculum is similar in many countries where it is given a special importance second only, if not equal to language" (p. 4). This is because of the importance given to it by educationists as well as parents. Mathematics is often associated with the fields of business, science and technology, which are essential for the economic development of any country.

Traditionally, learning mathematics involved memorization of concepts and formulae, as well as application of rules to specific problems. The focus was on getting the right answer and not on understanding the logic behind the process of finding the solutions (Firestone, 1989). Because of this focus, language was seen to have very little

significance to the learning of mathematics (Khisty, 2000). This approach to teaching mathematics was criticised for its lack of relevance to real life situations and, it was argued, often made the process of learning of mathematics difficult for learners (Pengelly, 1988; Walshaw & Anthony, 2008).

Barwell (2008) pointed out however, that language plays an important role in mathematics education saying, “the teaching and learning of mathematics is however, a process that, perhaps more than any other subject, depends on language” (p. 317). The reason for this he argued, was that mathematics ideas were presented through classroom talk and written texts. This view is also shared by Pimm (1987) who noted that “Mathematics is, among other things, a social activity, deeply concerned with communication” (p. xvii). Similarly, Reeves (1990), in discussing the connection between language and mathematics, proposed that mathematics education in schools was fundamentally a language activity. She further argued that “mathematical comprehension and skill development stems from a language or experience base” (p. 99). Context is paramount to learning. Reeves explained that young children learn by making sense of what they experience around them. Their language learning is interrelated to this physical experience, and its development is socially driven. Unlike language, mathematics is abstract and not bound by context. However, the main method students can learn it, is if it is presented in a context that they can relate to their own experience. Language plays an important role to link experience with mathematics ideas. Children form the social construction of mathematics ideas through language. Reeves described children’s mathematical development as, “a task for minds, dependent on listening to the language

models provided in the context of mathematical experience and having the opportunity to talk and experiment with language themselves" (p. 99).

While Reeves (1990) explored the relationship between mathematics and language from social and psychological perspectives, other researchers looked for empirical evidence to examine the connection. Aiken (1972), for example, reviewed eight studies to show correlations between learners' mathematics achievement and reading ability, as well as general intelligence. From the data gathered, he concluded that there was a positive correlation between students' reading ability and mathematics performance. Apart from being related to each other, scores on mathematical tests and verbal abilities were also correlated with general intelligence.

Research in the area of language and mathematics is not new in mathematics education. Jones (2004), in his review of research presented at Mathematics Education Research Group of Australasia (MERGA), noted that Australian researchers started to highlight the importance of language and mathematics in the early 1980s and the number of studies in this area continues to increase. The increasing awareness of the importance of language in mathematics education has resulted in the development of mathematics curricula which emphasise communication (Adler, 2001; Moschkovich, 2002). Teaching mathematics now not only involves training students to solve mathematics problems but also developing their linguistic ability to communicate mathematically. For example, the new Brunei primary mathematics curriculum (Khalid & Tengah, 2007) emphasises communication as one of the processes to be developed through mathematics content. In addition, the ability to communicate findings and provide explanations is considered an important learning outcome (Khalid & Tengah, 2007). Similarly, in the Malaysian

primary and secondary schools' mathematics curriculum, communication is seen as a way of sharing ideas and clarifying the understanding of mathematics (Ministry of Education Malaysia, 2003). More importantly, the curriculum also advocates the use of precise mathematics language, known as mathematics register: "When students are giving their opinion and solving problems orally and in writing, they are guided to use correct language and accurate mathematics register" (p. 2).

In mathematics research, Barwell (2008) noted that that there has been an increase in the level of interest among researchers on the issue of multilingualism in mathematics education. Multilingualism or bilingualism has become the focus of many research studies especially in countries where mathematics is taught in diverse classrooms (Adler, 2001; Moschovich, 2002; Setati, 2005).

With increasing recognition among mathematics educators that language interacts with mathematics learning, what is the implication for learners who have to learn mathematics in a second language? MacGregor (1993) stated that mathematics concepts were abstract, so the ability to discuss them requires mastery of complex language skills by the students. This would affect learners who have poor language skills and non-native speakers negatively. Before discussing the source of confusion for learners, the term *mathematic register* and what constitutes the register is discussed.

2.3. Mathematics Register.

In this section, the term *mathematics register* is discussed, together with its model of acquisition. A register is a language variety used in a particular field. Halliday (1978) defined mathematics register as: "The meanings that belong to the language of

mathematics (the mathematical use of natural language, that is: not mathematics itself), and that a language must express if it is being used for mathematical purposes" (p. 195).

Mathematics register is derived from natural language but the meanings are narrower in scope. According to Meaney (2002), mathematics register includes terminology and grammatical constructions, which are commonly used in discussing mathematics. For example, mathematics structure emphasises precision and brevity. Mathematics register however does not refer to terminology specific to the mathematics field only. Rather, it includes styles and mode of argument; "Convincing, arguing and explaining are all important aspects of mathematics and mathematics education" (Barwell, 2008, p. 318).

Halliday (1975) suggested that mathematics register comprises up to four basic components:

1. Natural language words reinterpreted in a mathematics context, such as *set*.
2. Locutions, such as *square on the hypotenuse*.
3. Compound words formed by combining words from natural language, such as *output*.
4. Terms created from combination of Greek and Latin words, such as *coefficient*.

Mathematics register can be confusing even to the native speakers for a number of reasons. First, a number of words have different meanings when they are used in everyday conversation than when used in discussing mathematics. For example, the word *prime* has different meanings when it is used in *prime number*, *prime time*, and *prime rib*. These differences in meaning can cause a problem in a classroom because students

normally use the colloquial meaning whereas mathematics teachers focus more on the mathematical meaning of the word (Moschkovich, 2002).

The second reason for confusion is that there are many words that can be used to signal mathematics operations. For example, addition (+) can be signalled by the words *plus*, *combine*, *sum*, *total*, and *increase by*. A third reason for confusion can be that translating mathematics statements into symbols can lead to mistakes as the order they are read in can be different from the order in which they are written. An example of this is the statement *ten divided by five* can be misinterpreted as $10\sqrt{5}$ especially by second language learners (Jarret, 1999). Farrugia (2006) added that homonymy is also a source of difficulty for the learners. Homonyms such as *sum/some* and *two/too/to* can confuse second language learners.

Linguistics difficulties such as those described above may cause problems especially for non-native speakers of English. There are a number of research studies which provide evidence for this. Adetula (1990) investigated students' performance and teaching strategies in solving verbal problems using the words *more* and *less.* Forty-eight students from private and public schools in Nigeria were given ten questions in both their first and second language, English. The findings showed that students performed better when the problems were presented in their first language. Similarly, a more recent study on students' competency in vocabulary used in junior secondary mathematics curriculum in Botswana by Garegae (2003) showed that first language learners did better than second language learners. She concluded that both ordinary English language and mathematical language pose two separate problems in a mathematics classroom. While first language learners might have problems with mathematics language, both languages affected

second language learners. More importantly, Garegae suggested that interventions targeting mathematical language problems should necessarily differ from those targeting competency in the English language. She argued that while students may acquire the language through informal discussion, teachers should make a deliberate effort to make sure that students learn the mathematics register. Her suggestion was supported by Zazkis (2000) who proposed that mathematics vocabulary be taught explicitly to second language learners. In order to be successful in mathematics, students need to learn to use mathematics register. The mathematics teachers, on the other hand, have to find the strategies to support this learning. Perhaps by understanding the process students go through in acquiring mathematics register, classroom instruction can be improved.

Several researchers like Gawned (1990), Donovan (1990) and Meaney (2006) have developed models to describe the acquisition of mathematics register. The first model is a socio-psycho-linguistic model (Gawned, 1990). As the name suggests, this model, shown in Figure 2.1, incorporates three components; social, psychology and linguistics to explain how language is developed when learning mathematics.

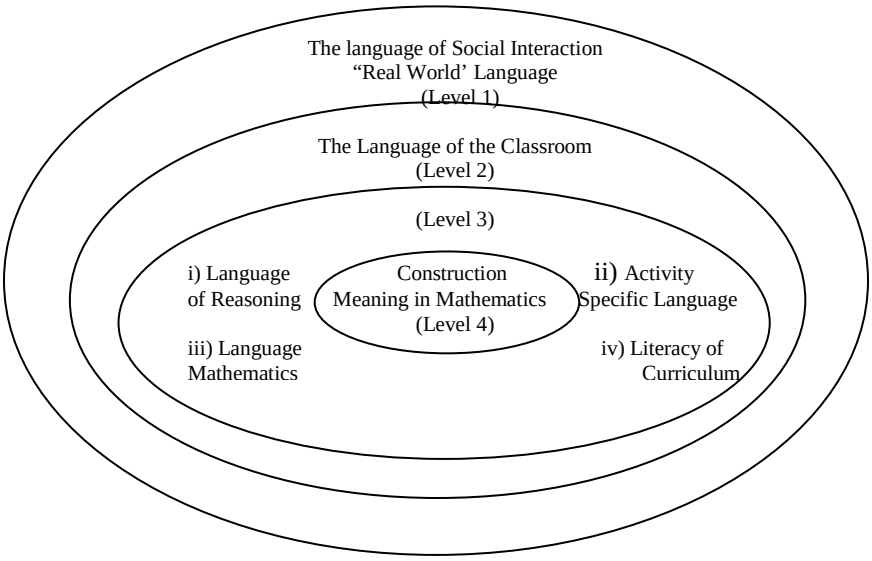


Figure 2.1.

The Socio-Psycho-Linguistic Model (adapted based on Bickmore-Brand, 1990, p.30)

The model proposes that children begin with the language of social interaction, as it is the foundation for all subsequent language development. Within this broad component, children also develop specific components like language of reasoning (e.g., when they make a choice), language of mathematics curriculum (e.g. describing shapes of things around them), activity specific language (e.g. describing a process) and the literacy of mathematics (e.g. dealing with numbers). Gawned contends that children develop their language because of their interaction with their environment, which includes their physical experience and perceptions, and the language of people around them. Early mathematics language can be developed from this real-world-language.

As children begin their formal education, Gwaned says they are introduced to the more formal language of the classroom. They learn the classroom discourse rules, for instance how to participate in a group or ask for assistance. The language at level one and two (see Figure 2.1) contributes to building more specific mathematics meaning at level

three. For example, the language of reasoning becomes the more specific language used for mathematics problem solving. Ultimately, at the end of this development continuum is the construction of mathematics meaning, a level at which students can independently construct mathematics meaning.

The Carawatha Language Development Centre has taken Gawned's model with minor modification, and applied it to classroom situations in Australia. The modified model, together with the samples of mathematics lessons was discussed by a group of researchers (Donovan, 1990). The Carawatha Language Development Centre is a special school, which provides specialized language intervention on an intensive basis for children whose academic, emotional, and social performance is severely limited by a profound neurological language delay or disorder. Similar to Gawned, Donovan proposed that children's mathematics language is developed in a similar, natural way as other language. Mathematics understanding begins at birth and is developed through a natural discovery process. Mathematics language is developed from the everyday language. Mastery of the language of mathematics results in literacy in mathematics. However, according to Donovan (1990), this prior knowledge becomes segmented in unrelated units of mathematics learning as children begin school. Therefore, it is important to establish continuation between students' prior knowledge of mathematics with formal mathematics learning. The researchers stressed that teachers should always plan mathematics activities that are related to students' experience using the non-specific terminology and build up the mathematics language from that.

Another model, which focuses specifically on the acquisition of mathematics register, was developed by Meaney (2006). The assumption that Meaney worked from

was that students acquire mathematics register in a similar way as they acquire their second language vocabulary. The Model of Mathematics Register Acquisition (MRA) describes the stages students go through in acquiring specific mathematic register. Understanding these stages is crucial for teachers in order to provide suitable support for their students. Figure 2.2 shows Meaney's stages in acquisition of mathematics register.

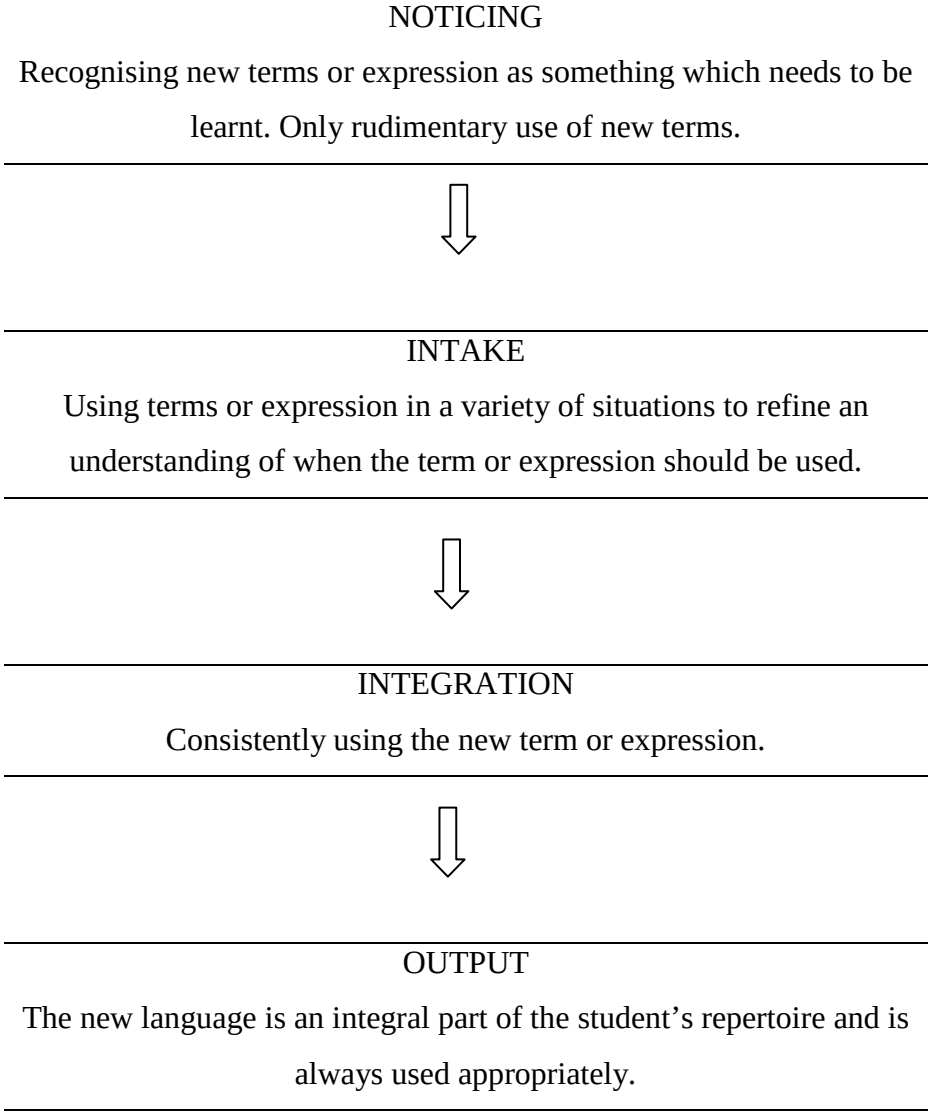


Figure 2.2.

Meaney's (2006) Model of Mathematics Register Acquisition.

The model suggests that learners go through four stages in acquiring mathematics register. At the noticing stage, students recognize the new term or expression to be learnt. The teacher plays an important role in prompting the students to do this. The teacher can highlight the terms by repeating, providing definition and rephrasing. At the intake stage, students are encouraged to use the term. The role of the teacher is to provide scaffolding

by asking leading questions. At the integration stage, students have understood the meaning of the new terms but still have some doubt about using them appropriately. The teacher can help by reminding the students of when to use the term. In the last stage, the output stage, students are able to use the expressions appropriately regardless of the situation. The teacher can provide support for students by providing opportunities for them to use the newly acquired terms. The teacher's involvement becomes less as students gain confidence in using the expressions. It is important for teachers to be aware of the stages that learners go through in the acquisition of mathematics register in order for them to develop relevant strategies that would support this acquisition.

In this section the term *mathematics register* was defined and some theories for its acquisition by students were discussed. Gawned's socio-psycho-linguistics model looks at the acquisition of mathematics register in a larger context, relating it to the children's interaction with the real world the mathematic. Meaney's MRA (Mathematics Register Acquisition) model focuses on a specific situation that is the classroom situation with ESL students. While both models are used in explaining acquisition of mathematics register, Meaney's model is more relevant to this study because of its focus on ESL students. In the next session, some SLA theories which are related to the learning of mathematics register were discussed.

2.4. Second Language Acquisition Theories.

In Section 2.3 it was argued that language factors do affect the processes of teaching and learning mathematics. In addition, learning of mathematics register is an essential part of learning mathematics. The contention that language plays such an

important role in learning mathematics is particularly significant to second language learners as they are learning the language of instruction. Therefore, an understanding of some key principles of language acquisition theories would be useful, especially to the teachers, in order to support the acquisition of mathematics register by the learners in their classrooms. This section will explore some of the theories that are relevant to the learning of a specific content area like mathematics, in a second language.

While learning mathematics in a second language proves to be a difficult task for learners, several researchers advocate the teaching of subject content in a second language. Through his Input Hypothesis, Krashen (1985) strongly supports the integration of second language and subject matter instruction. He argued that in order to acquire a certain language, learners need to have adequate exposure to comprehensible, interesting or relevant input in the language. While this theory was originally developed to explain second language acquisition, its application has been extended to academic learning in a second language. A content area such as mathematics provides natural, meaningful and interesting input for students and can thus facilitate language acquisition. Petrova and Novotna (2007) were in support of this hypothesis. They explored the issue of teaching and learning of mathematics in a foreign language in three countries: the United Kingdom, Germany and the Czech Republic. While the researchers showed support for Krashen's Input hypothesis in that mathematics content provided "substantive basis and exposure for language learning" (p. 1), their findings showed that second language learners faced several obstacles in terms of the use of the language of instruction. Petrova and Novotna recommended that teachers should be more sensitive to these language interferences and they devise teaching strategies to eliminate their

negative influence on learning. Among the pedagogical strategies suggested to teachers were: speak clearly; adapt the pace to the level of learners' language; introduce new vocabulary through exemplification; and use repetition more often especially with younger learners.

Other important theories are those developed by Cummins (1979, 1980). Cummins made a distinction between basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP). BICS is the language for face-to-face, informal conversation, which is described as being context-embedded and cognitively less demanding. This is because there are a lot of paralinguistic and situational cues present in this context, which can facilitate comprehension. CALP, on the other hand, is more context-reduced and hence, cognitively demanding. Learning a specific subject register falls into this category. For example, some of the academic language used in mathematics textbooks may be difficult for second language learners to understand. It is more difficult since learners have to rely heavily on linguistic cues. Cummins (1979) suggested that students take a longer time to acquire CALP due to its complexity. He concluded that while it took only two years for learners to acquire BICS, it could take them up to five to seven years to attain native-like fluency in CALP (Cummins, 2008).

The second theory is Cummins's (1979) Threshold Hypothesis, which explores the relationship between bilingualism and cognitive development. Cummins makes a distinction between subjective bilingualism, in which learners' first language is replaced by a more dominant and prestigious second language, and additive bilingualism, in which

a second language is added at no cost to proficiency of the first language. Additive bilingualism normally produces balanced bilinguals, who have similar, high competence in both languages. Cummins suggests that this type of bilingualism is likely to benefit the students' cognitive development. This is stated in his Threshold Hypothesis as: "those aspects of bilingualism which might positively influence cognitive growth are unlikely to come into effect until the child has attained a certain minimum or threshold level of competence in a second language" (p. 229).

The Threshold Hypothesis stresses the development of language proficiency in both first and second languages. Total replacement of the first language by the second language might result in delayed cognitive and academic development. Through the Developmental Interdependence Hypothesis, Cummins (1979) argued that the transfer of cognitive skills acquired in the first language to the second language is possible provided the learners have adequate exposure to the second language and are adequately motivated to learn the language. The Development Interdependence Hypothesis proposes that, "the level of L2 (second language) competence which a bilingual child attains is partially a function of the type of competence the child has developed in L1 (first language) at the times when intensive exposure to L2 begins" (p. 233). In other words, students who have developed strong academic skills in their first language are more likely to succeed in learning academic content in a second language. This theory may explain the fact that older second language learners are more successful in acquiring mathematics register because they have developed the academic skills in their first language (Cuevas, 1984).

Several researchers have used these theories in their studies. Among them is Cuevas (1984) who explored the issue of teaching mathematics in a second language

using relevant theories from second language acquisition. His findings showed that factors which affect first language acquisition such as age, the amount of exposure to the new language, the type of language instruction provided, and the influence of native language and culture might also affect the learning of mathematics language. Cuevas stated that, "to a large extent, the process is similar to the learning of one's first language" (p. 135). In a way, this finding supported the theories developed by Krashen (1985) and Cummins (1979, 1981). Cuevas suggested that understanding these variables in second language acquisition would help improve mathematics education for second language learners. He proposed that there should be a systematic language support for second language learners in their learning of mathematics.

Clarkson and Galbraith (1992) used Cummins's (1979, 1984) theoretical work as the guideline for their research in Papua New Guinea. The two theories that formed the basis of their study were Cummins's (1979) Threshold Hypothesis and Developmental Interdependent Hypothesis. The researchers gave a mathematics test as well as a language proficiency test to 27 Grade Six students from five urban community schools in Papua New Guinea. The result supported Cummins's Threshold Hypothesis as students with lower competency in both their first and second language attained significantly lower scores in the mathematics test administered by the researcher.

The work of Vygotsky (1962) is also significant in the field of second language learning. Vygotsky's Social Development Theory of Learning emphasised the importance of social interactions on students' cognitive development. This includes the development of language, thought and reasoning. According to this theory, learning mainly takes place through the student's interaction with more knowledgeable others, which include

teachers, peers or experts in certain field. In terms of learning of mathematics in a second language, Vygotsky's theory implied that in order for the learners to learn a new mathematics language, they need to interact with people who are fluent speakers of the language. The support of a more knowledgeable adult or peer can assist the learners in their academic development as well as their language development. This theory highlighted the important role played by the teachers, especially in a multilingual situation, in shaping the kind of desired interaction to support the learning of mathematics register by the students. This support is better known as scaffolding, a teaching strategy that has been developed by Wood, Brunner, and Ross (1979) from Vygotsky's theory. This strategy will be discussed further in section 2.6.

The theories presented above served as the framework underpinning the studies of discursive practice in teaching of mathematics in a second language. In the next section, the term *classroom discourse* is discussed and several studies which focused on discursive practice in multilingual contexts are reviewed in order to enrich the basis for discussion of the research reported in this thesis.

2.5. Classroom Discourse.

Based on the discussion in the previous section, it can be concluded that learning of mathematics register is an integral part of mathematics learning. However, in a classroom setting, it is difficult to separate mathematics register from everyday language because they are interwoven into the communication. In fact, what happens within the classroom discourse is complex. Therefore, to understand what is happening within the classroom discourse that can be identified as mathematics learning when it is so bound up

with language learning as well, more studies have to be done. In line with the mathematics curricula reform which focuses on mathematical communication, classroom discourse practice has become a subject of interest in many research studies especially in multilingual settings (Barwell et al. 2007).

The research reported in this thesis was conducted to explore the mathematics teachers' classroom discourse in two Malaysian primary schools. Before discussing similar studies in this area, the term *mathematics discourse* is explained.

Gee (1996) defines discourse as:

> ... a socially accepted association among ways of using language, other symbolic expressions, and 'artefacts', 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. (p. 131)

Based on this definition, Moschkovich (2002) concluded that mathematics discourse includes more than just the way of talking or writing mathematics, rather it also includes mathematics values, beliefs and points of view. Moschkovich says: "participating in classroom mathematical discourse practices can be understood in general as talking and acting in the ways that mathematically competent people talk and act" (p. 199). This view is supported by Van Oers (2001) who defines real mathematics activity as "an activity that is accomplished when one legitimately participates in a mathematical practice, either by acting mathematically in an acceptable way, or by discussing mathematical or discursive mathematical action." (p. 71). Hence, the ultimate

aim of mathematics education is for the students to be able to use conventional mathematical discourse.

Moschkovich (2002, 2005) explored other aspects of mathematics discourse practice including the different perspectives researchers took in examining the complex relationship between every day and mathematics discourse, as well as classroom communication: Her research review was mainly of studies in the United States of America on bilingual Latino students (Moschkovich, 2002). First, she discusses the sociolinguistic perspective which operated on the assumption that acquiring specific mathematics register was essential for second language learners in learning mathematics. Moschkovich work was associated with earlier studies including Dale and Cuevas (1987). It resulted in mathematics instruction that emphasised vocabulary and comprehension skills. While this was sufficient for a traditional mathematics curriculum, which focused on individual computation, and solving word problems, it is no longer applicable to the present situation, where mathematics learning requires students to communicate mathematically. This means that students are expected to participate in a variety of oral and written practices including presenting arguments. According to Moschkovich (2002), "if we focus on a student's failure to use a technical term, we might miss how a student constructs meaning for mathematical term or uses multiple resources such as gestures, objects or everyday experiences" (p. 182). The main limitation of this perspective was that students' competence in using mathematics language could not be assessed by looking at their ability to acquire the terminology only, as this would overlook the use of other resources used in mathematical communication, such as gestures.

Second, she presents the psycholinguistics perspective that describes learning mathematically as moving from using everyday language to more precise mathematics language. This view of learning mathematics still focused on vocabulary and failed to take into account the social context, whereas many of the meanings could be derived from the situation. Moschkovich (2002) argued that the two perspectives described above focused on the obstacles students faced rather than resources they could draw from the different registers (everyday and mathematical) and languages (first and second language) presented.

> "Descriptions of mathematical discussions in classrooms with bilingual students need to consider not only the obstacles that students face but also the resources students use to communicate mathematically" (p. 194).

Third, she demonstrates the situated-socio cultural perspective shifted the focus of mathematics instruction from language to mathematics content. From this perspective, "communicating mathematically is seen as using social, linguistic, and material resources to participate in mathematical practices" (Moschkovich, 2002, p. 197). Moschkovich gave two examples from classroom discourse to illustrate her point. In the first example, a student used gesture (pointing at the diagram) and a concrete object to replace a word she did not know. In the second example, a student used her first language as well as everyday experience to explain a mathematics concept. Moschkovich concluded that learners "can and do participate in discussion where they grapple with important mathematics content, even if they do not know the right word and even if they switch from English to Spanish" (p. 208). In exploring these different perspectives, Mochkovich concluded that in a multilingual context, it was important for the educators to look at the

discourse practices which can support the students' learning including gestures, use of the mother tongue and code switching. These practices, especially code switching, will be discussed in the next section.

Discourse practices are cognitive as well as social. While they are social because they arise from communities, they are also cognitive as they involve thinking, signs and meanings. Moschkovich (2005) stated that "mathematical discourse, however, is not a single set of homogeneous practices. It varies across individuals, communities, time, settings, and purposes" (p. 327). Thus, discourse practice varies socially, culturally and historically. Socially, discourse practice varies across different communities (e.g. between mathematicians and statisticians), involves different genres (e.g. algebraic proofs, geometric proofs) and mathematics arguments can be presented for different purposes (e.g. explaining, summarising). Mathematical definitions have changed over time (historically) and can differ across cultural contexts (culturally).

Richards (1991) described four types of mathematics discourse. First, research mathematics, which is the spoken mathematics of mathematicians; second, inquiry mathematics, which is used by mathematically literate adults; third, journal mathematics used in mathematical publications; and lastly, school mathematics, used in traditional mathematics classrooms.

The assumption is that learning mathematics involves a shift from everyday language to more precise mathematics language. Discourse practice is highly context dependent (Barwell et al., 2007). In a multilingual classroom, Setati (2005) summarised that communicating mathematically means managing the interaction among:

- ordinary English and mathematical English;

- formal and informal mathematics language;
- procedural and conceptual discourses; and
- learners' main language and language of instruction (p. 9).

In order to participate appropriately in any mathematical conversation, learners need to recognise the specific mathematics language needed in certain contexts. Besides, they also have to understand the differences between formal and informal mathematics language. The example given by Setati (2005) is the word *half,* which means any fraction of a whole. While it is common for learners to say *three halves* to refer to anything which is divided into three equal parts, the formal *word* for that is *thirds.* In the case of second language learners, it is even more complicated as the informal language is often not English.

In analysing the data for her research on discourse practice of a primary school teacher in South Africa, Setati (2005) divided classroom discourse into these categories:

- Mathematics Discourse
    a. Procedural discourse that is used by teachers to describe steps taken in doing mathematics.
    b. Conceptual discourse which is used to explain the reasons for calculating in a particular way.
- Non-Mathematics Discourse
    a. Regulatory discourse which refers to the language used mainly by teachers to regulate the learners' behaviour.
    b. Contextual discourse, that focuses on the context of mathematics task under discussion.

The type of discourse used in the classroom has certain impacts on the students' learning of mathematics. Van Oers (2001) suggested that students who were exposed to discourse of exploration and problem solving were more successful in tackling novel mathematics tasks than the students who were exposed to mainly procedural mathematics discourse. Based on his review of several studies in discourse analysis, Van Oers concluded that the teacher plays an important role in shaping the nature of classroom discourse.

The role of the mathematics teachers in multilingual classrooms is complex and demanding. They have to make sure that the learners have access to the language of mathematics, to English, the language of instruction and to a range of mathematical discourse. Walshaw and Anthony (2008) reviewed a body of literature on this theme. They agreed that students form their mathematics knowledge based on their everyday activities and cultural backgrounds, and the reviewers argued that quality discursive interactions build on this knowledge. Furthermore, they added that "teaching that is effective is able to bridge students' intuitive understandings and the mathematical understanding sanctioned by the world at large" (p. 540).

Studies by Khisty and Chval (2002) and White (2003) provided evidence for a point brought up by Walshaw and Anthony (2008). Khisty and Chval (2002) observed classroom interaction between a teacher and her fifth-grade Latino students. The findings showed that the teacher's own use of mathematics language could facilitate the students' development of their mathematics language. This finding supports the view that, in a second language situation, students rely heavily on their teachers for language input in order to construct the meanings and use the language appropriately. Another study of the

classroom practice of two third-grade teachers teaching in a school in Washington DC adds further support to this idea. The students in White's (2003) study represented various ethnic groups, namely Asian, Hispanic, Black and White. From the findings, White suggested that teachers could promote productive classroom discourse by engaging students in discussion and directly encouraging them to participate. Through discussion, students are able to share ideas, and teachers can reflect on the students' understanding of mathematical ideas.

There are several studies which focussed more on teachers' classroom discourse. One of them is by Khisty (2000) who conducted observations in two middle grade classrooms, with a significant number of Hispanic students. The teachers were native Spanish speakers, who had experienced all their schooling in the United States of America. The teachers did not have any specialisation in mathematics but each had a certificate qualification in bilingual education. The analyses of the data showed three significant patterns in the teachers' discourse. First, very little attention was given to the mathematics register. Second, the discourse pattern in both classrooms was mainly procedural in nature. Third, very little Spanish was used. The use of Spanish can be classified into two categories. The first category was instrumental, because teachers use the language as an instrument to call for attention or to reinforce instructions. The second category was what the researcher labelled as markers of solidarity, in which Spanish was used to give encouragement.

Setati (2005) carried out a similar study in a primary school in Johannesburg, South Africa. She observed a teacher, Kuki, teaching a grade four classroom. First, procedural discourse in English dominated Kuki's teaching. Second, Setwana, the first

language, was used as voice of solidarity, which the teacher used to support and advise the learners. Thus Setati's findings showed some similarities with Khisty's (2000) study.

This section has highlighted the complexity of classroom discourse, especially in a multilingual setting. Studies on discourse patterns are important in order to help identify effective mathematics teaching approaches in multilingual learning contexts. The research study by Khisty and Chval (2002) showed that the teachers were seen as model language users by second language learners. Besides providing the appropriate use of language, teachers' discourse helped learners to construct mathematical meanings, and supported the development of their conceptual knowledge. White (2003) recommended that teachers should provide a conducive environment for learners to participate in discussion, which in turn, would help develop their mathematics competence. There were some similarities such as the predominant use of procedural discourse by the teachers; between the analysis of the teachers' discourse undertaken by Khisty (2000) and Setati (2005) even though the research settings were different.

2.6. Teaching Strategies for Teaching Mathematics in a Second Language.

This review, thus far, has shown that classroom discourse practice has significant impact on mathematics learners especially in multilingual contexts. At this point, it is useful to examine some teaching strategies which can be derived from discursive perspectives. As discussed earlier in Section 2.5, bilingualism or multilingualism should not be seen as an obstacle in mathematics learning. Gestures, students' first language, and everyday experience can be used as resources in mathematics classrooms (Moschkovich, 2002). This section reviews the research literature on two main teaching strategies related

to discourse practice: scaffolding and code switching. Meaney et al. (2007) stated that "although the effect of scaffolding on mathematical language has been known for some time, there has been limited research on what are effective scaffolding strategies" (p. 494). The choice of code switching was made as it was a common strategies mentioned in several studies conducted in multilingual situation such as research by Setati (2005, 2008); Setati & Adler (2000); Kasule & Mapolelo (2005).

Scaffolding is a technique developed by Wood, Brunner and Ross (1979) based on Vygotsky's Zone of Proximal Development. Generally, this proposition stated that a child can only take the next step in their cognitive development with the help of more knowledgeable other, most probably a teacher, who supports and prompts him or her to do so. The support and prompt used by the teacher is known as scaffolding.

Bickmore-Brand and Gawned (1990) defined scaffolding as, "the practice of building on what the child appears to know in order to stretch the child to the next stage of development" (p. 43). Basically, scaffolding is the context provided by the knowledgeable person to help the children develop their cognitive skills. Greenfield (1984) provided a more detailed description to further illustrate the concept of scaffolding:

> The scaffolding is a metaphor to describe the ideal role of the teacher. The scaffold, as it is known in building construction, has five characteristics: to provide a support; it functions as a tool; it extends the range of the worker; it allows the worker to accomplish a task not otherwise possible; and it is used selectively to aid the worker where needed. To illustrate this last point, a scaffold would not be

> used, for example when a carpenter is working five feet from the ground. (p. 101)

The building in this metaphor represents the knowledge, while the workers are the students. When the work is completed, the scaffolding is taken off the building. Similarly, in the learning situation, scaffolding only serves as "a temporary framework providing a platform for the next step towards adult communication" (Bickmore-Brand & Gawned, 1990, p. 46). When a child has gained mastery, the scaffolding is gradually taken away.

In mathematics learning, scaffolding is used not only in helping students to learn mathematics register, but also to complete a certain task (Bickmore-Brand & Gawned, 1990). Holton and Thomas (2002) stated that teachers use scaffolding for two reasons. First, scaffolding provides an immediate solution to a problem at hand and second, it provides practice in which a similar method could be used in the future.

Scaffolding in mathematics teaching and learning includes contextual supports for meaning using simplified language, modelling and diagrams (Yuliati, 2008). A distinction between scaffolding and modelling is made by Meaney et al. (2007). For them, modelling is when the teacher uses mathematics language in an appropriate context while scaffolding is more like prompting, when a teacher provides part of a response with the student completing the text.

Meaney et al. (2007) conducted a study on the use of scaffolding and modelling by teachers when teaching mathematics in a Maori immersion school (Kura Kaupapa Maori), where Maori was the language of instruction. Lessons taught by seven mathematics teachers in 2005 and 2006 were videotaped and analysed in order to identify teaching strategies used and how they were arranged according to stages in the

Mathematics Register Acquisition Model (Meaney, 2006) discussed in section 2.2. The researchers concluded that teachers use a combination of strategies according to the stages in the MRA model. As students move to a later stage, the teacher becomes less in control of the acquisition process. The teacher, therefore, reduces the amount of scaffolding provided, thus "transferring the responsibility for using the language from teacher to the student" (Meaney et al., 2007, p. 494). The students become responsible for acquiring the mathematics understanding on their own after they have mastered some basic mathematics concepts. The researchers also concluded that while scaffolding and modelling strategies are recommended especially in the acquisition of mathematics register, these strategies should not be judged as effective in isolation because the teachers observed used a combination of strategies at all stages of the MRA model. On the other hand, Yuliati (2008) concluded from her observation of two teachers in Indonesia that the use of too many clues, explanations and descriptions might turn students into passive learners.

Another strategy that is associated with classroom discourse practice is code switching. Code switching is described as a change by a speaker or writer from one language or language variety to another (Kasule & Mapolelo, 2005). Code switching is a common practice especially when the teacher shares or knows the learner's first language (Cook, 1991). While code switching was once viewed as a deficiency on the part of the speaker (i.e., teacher or learner), it is now an acceptable teaching method which makes use of the learners' first language as the resource. Moschkovich (2005) stated that it was a misconception that code switching was regarded as a reflection or consequence of a missing word in the speaker's lexicon. Instead, it should be seen as the speaker making

use of the resources (including the speaker's first language) available to her or him to communicate. Moschkovich explored the concept of code switching using sociolinguistic and psycholinguistic perspectives. Sociolinguistics research shows that a bilingual child's choice of language seems to be dependent on the person addressing him or her. Another view of the sociolinguistics research is that code switching is a social practice that is very much connected to a community's norms. Thus, in a mathematics classroom, students will speak as they are spoken to by the person addressing them and their use of code switching is guided by the social norms around them. The implication of this assumption for mathematics education is that a researcher needs to consider many aspects of a situation in order to describe the teacher or learner's choice of language. For example, socially, it is important to consider whom the speaker is addressing and whether the setting is private or public. Focusing on mathematics, a researcher would need to look at the mathematics activity the person is engaged in and the topic concerned, as well as the learners' experience with mathematics instruction in each language. An example of this is, a learner might use his first language when working on arithmetic computation alone but might switch to the second language when explaining the procedure to the teacher. The first situation is a private one and the learner might be introduced to arithmetic in his first language. On the other hand, the latter situation is more formal and the teacher might expose the learner to procedural discourse in the second language.

There are a number of reasons for code switching. Arthur (1996) carried out research into classroom interaction in Standard Six classes in two primary schools in Botswana. The lessons which were observed were English, mathematics and science. The findings showed that teachers switched to the first language to explain ideas and

encourage students' participation. Lin (1996) looked into code switching practices in secondary schools in Hong Kong. She emphasised the importance of contexts for code switching. Teachers were observed to switch to Cantonese, the first language in informal situations, such as when reprimanding the students for not doing their homework. English, on the other hand, was used in formal parts of the lesson. While English was the language of education, the first language, Cantonese, served as a tool for bridging the unfamiliar context with the learners' familiar experiences.

Research in multilingual mathematics education offered insights into some of the situations for code switching. Setati and Alder (2000) carried out a study in ten rural and urban, primary and secondary schools in South Africa. The participants were selected among teachers who were the participants of an in-service teacher development programme known as the Further Diploma in Education (FDE). The study was conducted over the period of three years, 1996 to1998, during which time each teacher was observed for one week each year. The number of participants was twenty-five in 1996, twenty-three in 1997 and eighteen in 1998. The data included videotapes of the lessons, transcribed interviews with teachers, teachers' narratives, teachers' responses to questionnaires and examples of the learners' work. The aim of the study was to look at the teachers' classroom practice, with particular focus on the relationship between teachers' practice and the practices in the FDE programme.

The findings of this study can be summarised as follows:

The use of code switching increased in the period of three years of the study.

- Code switching was observed least in rural primary schools.
- More code switching was used in secondary schools than primary schools.

- More code switching was observed in additional learning situations, whereby learners had more exposure to English even outside the classroom than foreign language situations, where learners had limited exposure to English, mostly in a school setting. (Setati & Alder, 2000)

The researchers concluded that the findings reflected the complexity of the language issue in rural primary schools where teachers felt obliged to model and encourage the use of English, as the classroom was the only place where students were exposed to it. Another interesting finding was that the teachers used English predominantly in the public domain but could switch to the learners' main language for reformulation and interaction with individual learners or small groups.

Apart from investigating the teachers' discourse practices in general, Setati and Adler (2000) also focused on an individual teacher, Ntombi, to examine her teaching strategies in teaching mathematics to multilingual students. The findings showed that the teacher focused mainly on formal mathematics language. In terms of modelling, the teacher's language was clearly reflected in the students' language. A significant finding about the practice of code switching was that the teacher used Twana, the first language of the teacher and students, for informal conceptual discourse but switched to English for formal calculation discourse.

From these studies, Setati and Alder (2000) came to the conclusion that the use of code switching depends on the language of learning and teaching (LoLT) infrastructure, that is, whether it is a foreign language learning environment or additional language learning environment. As a result, the use of English is greater in rural schools (foreign language learning environment). Code switching is also connected to the movement

across mathematics discourses, from formal to informal language, and from mathematics language to non-mathematics language. For example, Twana is used for informal conceptual discourse.

Another issue raised by the researchers was the dilemma faced by the teachers over the use of code switching. On one hand, the teachers felt the need to use the first language to facilitate communication and understanding, but at the same time, they felt that it was their responsibility to induct their learners into mathematics English, as it was the language of instruction and assessment. In discussing the same issue, Kasule and Mapolelo (2005) reported a similar dilemma faced by school administrators, which was to determine how much code switching is desirable and effective because over reliance on it could result in misuse. On the same note, Akindele and Letsoela (2001) found, from their studies on code switching, that some teachers made gross errors in their code switching and translation from English to the first language. They argued that the errors happened because of the highly technical nature of the discourse. Furthermore, translation is a specialist skill and teachers are not qualified to carry out the task.

Farrugia (2003) highlighted similar points as Setati and Adler (2000) with regard to the practice of code switching in the mathematics classroom. In the new mathematics curriculum developed by the Maltese Ministry of Education, one of the recommendations was that mathematics should be taught in English and the practice of code switching was discouraged. The researcher argued that this recommendation was not practical because code switching served an important role in communicating mathematics ideas in the classroom, “when and why a teacher should code switch is not a straightforward choice” (Farrugia, 2003, p. 11). One important point that can be concluded from this review is

that there is a separate domain for the use of first language and second language. The second language, English, which is the official language of instruction, is normally used in formal, public situations. But, the first language is used in informal situations especially when the teacher is addressing a small group or individual students. The dilemma in code switching practice always remains. Teachers realise the importance of providing students with mathematical input in English, but at the same time have to revert to the first language to ensure understanding. Despite all the issues surrounding the use of code switching, learners should be taught to use good mathematics language in English (Zazkis, 2000), because good language signifies good understanding (Zazkis, 2000). As for the teachers, the use of informal language -normally in the first language- should be a pedagogical choice rather than indicator of their lack of proficiency with the mathematical language.

2.7. Conclusion.

This chapter has explored the relationship between language and mathematics education. Language becomes an integral part of mathematics education especially with the shift in mathematics curricula commonly seen now places an emphasis on communication. The premise is that for learners to succeed in learning mathematics, they need to master mathematics register. However, since it is difficult to separate mathematics register from everyday language, the focus of research in this field is mainly on discourse practice.

In a way, the learning of mathematics register is similar to the acquisition of any new language. Therefore, second language models and theories of acquisition form the

base for developing teaching strategies for teaching of mathematics in a second language. However, learning mathematics register is difficult especially for students who are learning mathematics in a second language. A few researchers including Moschkovich (2002) suggested that bilingualism should not be viewed as a factor which hinders mathematics learning; rather it should become part of resources to support learning Studies in multilingual contexts for teaching mathematics showed that teachers play an important role in supporting the acquisition of mathematics register by their learners. Two main strategies derived from classroom discourse practice, scaffolding and code switching, were discussed.

Scaffolding refers to the supports and prompts used by teachers in developing students' mathematics learning. Code switching is the alternation in the use of first and second languages in a single speech. This strategy is, perhaps, a controversial one since there are different views about its use.

CHAPTER THREE

EDUCATION IN MALAYSIA

3.0. Introduction.

This chapter provides a description of the context for the research. It begins with accounts of the historical and socio-economic contexts of Malaysian education. Then, the use of English language by Malaysians is discussed in order to provide better understanding of the multilingual context for teaching and learning in Malaysia. The next section outlines the language education policy in Malaysia, and events which led to the introduction of teaching of mathematics and science in English (ETeMS). This chapter ends with the discussion of implementation of ETeMS in Malaysian schools.

3.1. The Malaysian Education System.

Malaysia is situated in South East Asia. It is made up of two distinct parts, West Malaysia, which was part of Asia and East Malaysia in Borneo Island. In 2009, the population of Malaysia was approximately 28 million.

Because of its strategic location, Malaysia had been colonised by three different nations prior to its independence. The Malay Peninsula was colonised by Portugal in 1511, followed by the Dutch in 1641 and most recently British in 1824. However, it was the British colonials which had the most influence "in shaping Malaysia's economy, society and politics" (Ibrahim, 2007). The British *Foreign Labour Importation* policy

caused an influx of Chinese and Indian labourers who worked in the mining and rubber industries. When Malaysia gained its independence from the British in 1957, most of those labourers chose to stay on and were granted citizenship. This was the beginning of multi-ethnicity in Malaysia. Now, Malaysia is a multiracial country with three major ethnic groups: Malay, Chinese and Indian. Each group has its own distinctive culture, language and religious affiliation.

Another policy implemented by the British was the *divide-and-rule* policy. With this policy, the multiethnic population of Malaysia was segregated according to economic sectors. The Malays worked mostly as farmers and fishers in the rural areas. The Indians occupied the rubber plantations and the Chinese stayed in the mining areas and carried out business in urban areas. Although the people in Malaysia have moved around since independence, some have remained in the same areas. As a result, the rural areas in Malaysia are still dominated by the Malays, while a more multiethnic population can be found in the urban areas.

As stated earlier, “Malaysia is a society divided by race, language, religion, culture and to some extent by occupational and regional difference” (Lee, 1998, p. 89). The multiethnic society has had many impacts on education in Malaysia. Initially, there were four major education systems, which were divided according to the language of instruction. During this time, the system of education that existed in Malaya (Malaysia’s name prior to its independence) was a fragmented system (Foo & Richards, 2004). The Malays attended religious schools conducted by Muslim missionaries (Gaudart, 1987). The Chinese and Indian set up their own schools in which their mother tongues were the media of instruction (Foo & Richards, 2004).

When the British came to Malaysia, Christian missionaries established English schools. Later on, the success of these mission schools prompted the colonial government to introduce government English schools. English schools were opened to all races but they were situated in urban areas (Gaudart, 1987) because the Christian missionaries were not allowed to set up schools in rural areas dominated by the Muslim, Malay population. Therefore, English education was only available to the Chinese, Malay royalty and rich families who resided in the urban areas. Soon, English schools began to flourish because many people felt that being educated in English would guarantee them better jobs in the government and private sectors (Asmah, 2003). Heng and Tan (2006, p. 308) stated that "vernacular schools only produced literate farmers, carpenters and small time shopkeepers", while English education offered pupils upward social mobility.

This scenario changed after Malaysia gained its independence in 1957. The new government felt that a language should be chosen to unite the different linguistic groups that existed. Malay, being the language spoken by the most dominant ethnic group, was chosen as the official language (Asmah, 1996). In education, there was the need for an integrated education system. Schools needed a common curriculum and language of instruction for unity purposes. National Education policy, which was developed based on the Razak Report 1956 and the Education Ordinance 1957, aimed at building a national identity and promoting integration among Malaysian society (Ibrahim, 2007). In line with the National Language Act 1963, Bahasa Malaysia became the language of instruction at all public schools. In 1970, English schools gradually began to be phased out, being replaced by national schools and national-type schools. By 1983, Bahasa Malaysia had become the medium of instruction at all levels of schooling including the tertiary level.

Since then, English has been taught as a core subject, just like any other academic subject.

Basically, the system of education in Malaysia follows a 6-3-2 structure. Students begin schooling at the age of seven and study in primary schools for six years. They then continue their studies in lower secondary for three years and another two years in upper secondary. At primary level, there are two types of schools, namely, the national schools which use Bahasa Malaysia as the medium of instruction, and national-type schools, which are made up of Chinese and Tamil schools. Students at primary schools have to learn five subjects: Bahasa Malaysia; English; mathematics; science; and Islamic or moral studies. In secondary schools, students have to learn eight core subjects and take two or three electives.

Teachers in Malaysia are trained mainly at twenty-seven institutes of teachers' education (IPG) and local universities. Until the year 2005, thirty-eight percent of these teachers were university graduates while the rest were diploma holders. The Ministry of Education set a target of one hundred percent university graduate teachers in secondary schools by 2010. Teachers are trained according to specific subjects like science, mathematics and English. At schools, they are responsible for teaching the subjects they have specialised in during training. The Ministry of Education is fully responsible for providing the training necessary for pre-service and in-service teachers. After completing their training, teachers are assigned to their respective schools by the Ministry of Education.

The education system in Malaysia is highly examination oriented. Throughout their school years, students face three major examinations: at the end of primary school in

Year Six, at the end of lower secondary in Form Three and at the end of upper secondary in Form Five. All these major examinations are very important, as they not only assess the teaching and learning process, but they also determine each student's education pathway. Students are put into different classes and schools based on their examination results. For example, students who obtain good results in their primary school assessment examination (UPSR) have a better chance of getting into more prestigious secondary schools. Lim and Ping (2005) stated that "all examination results are taken seriously by both schools and parents as a measure of the school accountability and individual pride" (p. 2). The exam-oriented system has a number of implications for the teaching and learning process in Malaysia. Lee (1998) summarised the impacts by saying that "over-emphasis on public examination results has resulted in a certain teaching-learning strategies such as rote-learning, and spoon-feeding, strategies that may not be suitable for a fast industrialising society like Malaysia" (p. 96). In other words, the students' focus tends to be more on memorising basic facts than on deeper understanding and analysis of the knowledge they have learnt. The teachers' main focus tends to be on helping students pass the examinations, which results in the teaching of only the basic skills and knowledge that are going to be tested and ignoring those not included in the examination. An education system which emphasises examination results can put constraints on teachers' creativity and teaching styles, as well as hindering students from taking more responsibility for their learning.

As stated earlier in this section, the schools in Malaysia share a common language and syllabus. Hence, the educational climate in Malaysia can be characterised as prescriptive, with nationwide published syllabi, common textbooks for all schools and

nationwide examinations. Another distinct feature of Malaysian education system is that, teachers are dominant figures in the classroom. Tan and Samyudia (2009) made an observation about the relationship between teachers and students in Malaysia. They said that in teacher-centred classes, students are not encouraged to voice their opinion, resulting in them becoming more passive in class. Similarly, Aman and Mustaffa's (2006) analysis of a Malay language teacher's classroom discourse showed the teacher controlling the discourse as well as the students. The teacher preferred to give explanations rather than encouraging the students to discuss and analyse the problems in order to find the answers. Another feature noted by the researchers was the limited students' involvement during the classroom interactions. The teacher did not provide opportunity for the students to give their opinion, so, students involvement was confined to answering the teacher's questions only. This suggests that teachers are inclined to be the dominant figure in the class, being in control of the learning activities and the students.

The discussion thus far has been on the education system in Malaysia which has provided the context for the research. The use of English in Malaysia is discussed in the next section. This is followed by discussion of the reasons for the policy decision to change the language of instruction from Bahasa Malaysia to English.

3.2. English in Malaysia.

As mentioned earlier, as a former colony, English has always been highly regarded by the people in Malaysia. However, with vigorous efforts of promoting the use of the national language, Bahasa Malaysia, after independence, the standard of English

among Malaysian students was deteriorating. This was evident in poor results that the students attained in the National English Public Examination (UPSR) in recent years. For example in 2003, the result of UPSR showed that of 400,000 candidates who sat for the exam, only sixty-eight percent passed the English paper. Similarly, at secondary level, English was the core subject with the lowest percentage of passes, namely sixty-seven percent (David, 2004). The decline in the standard of English among Malaysian students caused great concern among educators and the public in general.

Another related issue was the lack of support for the acquisition of English by students in rural areas. As mentioned earlier, the population in rural areas is made up mainly of Malays. Most people use their mother tongue at home and in other personal domains but they use English to communicate with speakers of other languages in the community. Since the population in rural areas is mainly of one ethnic group, the environments in rural areas do not support the learning of other languages including English. So, while there was a uniform effort by the government to promote the use of English, there is still a gap between the learners in rural areas and their urban counterparts. This non-conducive environment and the shortage of qualified English teachers have made matters worse for students in rural areas.

The decline in English language proficiency among the students was the main factor which triggered the change in language of instruction from Bahasa Malaysia to English. This change will be explained further in the next section.

3.3. Language in Education Policy in Malaysia.

The main goal of education in Malaysia is to promote national unity and economic growth. This goal is reflected in a number of government documents such as the Millennium Development Goals (MDG) which states that "changes and reforms in Malaysia's education system reflect the government's efforts to adapt education to national development needs, in particular economic growth, poverty reduction, human resource development, and national unity" (Ministry of Education Malaysia, 2007, p. 75). In 1991 the government devised an economic plan, Vision 2020, which targeted 2020 as the year Malaysia would achieve the status of an industrialised and developed country (Mahathir, 1991). Education plays an important role in realizing this vision as it would provide the human resources for economic growth. Globalisation has created an urgency to upgrade the education system especially with regard to the mastery of English among students.

The government was also concerned with the decline of the standard of English among students. This aspect was seen as a factor which could affect the country's chance of becoming a developed nation by the year 2020. The students' lack of proficiency in English was also identified as one of the causes for the increase in unemployment among graduates. The Malaysian government felt that it was necessary to address these problems in order for the country to remain competitive (Heng & Tan, 2006). In response to the increasing demand to upgrade the use of English among the students, the government decided to reintroduce English as the language of instruction for the teaching of mathematics and science starting from the year 2003. This move was felt necessary as it would increase the students' level of proficiency in English, as well as their

understanding of the two subjects, mathematics and science. The importance of this decision to change the language of instruction was summarised in the former Education Minister's keynote address in 2003 English for Teaching of Mathematics and Science conference:

> It is the aim of our education system to develop world class citizens, who are able to compete among the best in the developed countries of the world. In order to address this challenge, the government planned and implemented, among others, ETeMS (English for Teaching of Mathematics and Science) [Muhamad, 2003, p. 12].

Another reason for this change in the language of instruction for mathematics and science was that English was considered a language for wider communication compared with the national language, Bahasa Malaysia. English is commonly used in the fields of business, science and technology. While Bahasa Malaysia is important for national identity and unity, mastery of English is seen as a way of ensuring that Malaysians gain greater access to information. In this globalization era, Malaysian could no longer rely on translated materials, as translating is a slow process (Gill, 2005). Besides getting information, Malaysians could use English to communicate their views internationally. Fluency in English would enable them to participate in activities beyond their national boundaries and help them to form networks with people around the world.

It was clear to Malaysians that knowledge of English was important for the development of the country. It would help in building a more efficient workforce, and, presumably, would attract more foreign investment.

However, the decision to reintroduce English as the language for teaching of mathematics and science received mixed reactions from various ethnic groups in Malaysia. The Malays were mainly afraid that the change would threaten their national language and identity (Ibrahim, 2007). They felt that the change would cause difficulties for students in rural areas, who were generally weak in English. Since most of these students were Malays, they argued that it would only widen the gap between students in rural and urban areas (Abdullah & Heng, 2003). The Chinese were opposed to any change in language for a similar reason; it was a threat to their cultural identity. Besides, they did not see any reason to change since their students were doing well learning mathematics and science in their own mother tongue. This claim was supported by data showing that students in Chinese schools performed better in both subjects than those in National schools (Heng & Tan, 2006).

On the other hand, those who supported the use of English had pointed out that perpetuating the use of Bahasa Malaysia would only create more problems, especially when students reached tertiary level. At this point, they would have to do a lot of reading and referencing in English. Furthermore, it seemed unreasonable to learn terminology in Malay (e.g. *tenaga* for energy) only to use the formula in English (e.g. $e=mc^2$). The symbol of *e* for energy was used worldwide and would not be replaced with others.

As with any other policy change, a change in language needs time to prove its effectiveness. Besides, this was not the first time the Malaysian education system had gone through a language change. It happened in the 1970s when the government decided to use Bahasa Malaysia to replace English. However, this dilemma continued to pressure the government into making the decision whether to continue using English or revert to

Malay again. One of the strongest arguments against the change in language policy was that it was a reversal of section 17(1) Education Act 1996 which stated that the national language should be the main medium of instruction in all educational institutions in the National Education system except the national-type schools (Gill, 2005).

Then, after making the change in 2003 to teach mathematics and science in English, in 2010, the language of instruction for teaching of mathematics and science was reverted to Bahasa Malaysia due to the political pressure to preserve the use of Bahasa Malaysia as a national language. It was decided that the decline in English language proficiency would be addressed through increasing the number of English periods in schools and training English teachers.

It is clear that any decision regarding policy change in Malaysia including those involving language are top-down because they come from the people of power and authority who make the decisions for certain group, without consulting the end-users of the language (Gill, 2005).

The research reported in this thesis was begun in 2007, four years after the initial implementation of the language change. The data for this research were collected in 2009. At the end of 2009 the government announced the reversal in language policy, back to Bahasa Malaysia beginning in 2010. The implementation of the change from English to Bahasa Malaysia is being done gradually. Students who have started to learn mathematics and science in English will continue to do so until they finish their schooling years. This change, does not affect this research since the data collection process had been completed earlier.

3.4. Issues in Teaching Mathematics in a Second Language.

The change in language of instruction from Bahasa Malaysia to English came into effect at the beginning of 2003. It was implemented in progressive phases starting with lower primary level (Year One), lower secondary (Form One) and pre university (Lower Six). By the year 2010, the changeover period would have been complete with all students in Malaysia at all levels of education learning mathematics, science and other related subjects such as chemistry and biology, in English. This section discusses the issues in the implementation of the language change. First, it discusses the steps taken in order to ensure the smooth implementation of the policy. Then, the challenges in the implementation of the policy are outlined.

The change in the language of instruction for teaching of mathematics and science involved some major changes in schools. First, the curricula for these subjects were translated into English by the Curriculum Development Centre (CDC). Then, the text book committee began translating and adapting the textbooks for the subjects with the help of a panel of language experts. Vendors were also contracted to design and supply teaching courseware in English. All schools were provided with facilities including LCD projectors, trolleys with speakers, and all teachers teaching mathematics, science and English were given laptop computers for their use in teaching the subjects. The government had allocated approximately RM 5 billion for the implementation of this programme between 2002 until 2008 (Pillay &Thomas, 2003).

A number of problems arose from the decision to change the language of instruction for mathematics and science to English. First, there was a problem of insufficient mathematics and science teachers who were fluent in English to teach these

subjects (Abdullah & Heng, 2003). Most of the teachers were trained in Malay and those who were trained in English had been using Malay in their teaching for more than twenty years (Ismail, 2003). At the same time, there were insufficient teachers to teach English. This was compounded by an acute shortage of teachers capable of teaching mathematics and science in English (Abdullah & Heng, 2003). In order to implement the language policy, the Ministry of Education was faced with the challenge of retraining a large number of teachers, approximately 25,000, in a short period of time (Foong, 2004).

Second, with the policy reform, science and mathematics teachers found that they were faced with the double challenge of teaching their subject in English while learners were still learning the language (Pandian & Ramiah, 2003). The main problem in a bilingual or multilingual classroom is communication (Gorgorio & Planas, 2001). Problems arise if the teachers do not share the same language with the learners. According to Gorgorio and Planas (2001), initial communication is important for teachers to determine learners' starting points in learning mathematics. Even when teachers understand the learners' first language, a problem still arises in terms of getting the message across in the second language. Teachers face the challenge of teaching mathematics in a language that learners are still struggling to understand. Furthermore, learners in the same class may have different levels of fluency in their second language. Teachers need to adjust their teaching so that the lesson is challenging enough for the *good* students and not too difficult for the *weaker* ones (Sam et al. 2009).

Teachers were faced with the challenge of improving their English proficiency to deliver the content effectively and provide examples of appropriate use of mathematics language. Heng and Tan (2006) stated that teachers faced a special challenge in having to

acquire the necessary English skills for immediate use in the classroom. In her observation of ten mathematics classrooms in Malaysia, Sidhu (2005) found that this problem had given rise to the use of colloquial language in classrooms. The term *colloquial language* here is used to describe the Malaysian-style of speaking in English, which combines the Malay language structures and words with English. An example Sidhu (2005) gave of this is, "Okay, can you add twelve and three, and how much now?" (p. 57). She suggested that this problem arises because of the teachers' lack of fluency in English. This was seen as a cause for concern because it could hamper the communication process between teachers and students. Teachers and students might not be able to communicate effectively, more so to communicate using precise and accurate mathematics language (Lim & Chew, 2007).

Other studies lent support to the concern that teachers' English competency was still low (Kon, 2004; Norzita, 2004; Pillay & Thomas, 2003). Kon (2004) added that teachers were less confident especially with their pronunciation of specific terms. Kamsilawati (2005) observed that there was lack of awareness among teachers of specific mathematics language or mathematics register. This finding was alarming because, as discussed in Chapter Two, learning the mathematics register is integral to learning mathematics. In a study conducted by Pandian & Ramiah (2003), interviews with mathematics teachers revealed that they were not clear about the features of mathematics register, which meant they might not be able to help the students cope with academic language.

Another problem faced by teachers in many countries is overcrowded classes. Teachers in Malaysian primary schools also face the same problem. For example, it is

common to have forty students in a classroom (Lim & Wun, 2003). This makes it difficult to implement some useful strategies such as games or group work. It is also difficult for teachers to monitor the interaction that takes place in the classroom. On top of that, teachers are pressured to prepare students for public examinations. As discussed earlier, students in Malaysia face three major examinations throughout the school years. Schools are ranked according to their students' achievement in these examinations. Kasule and Mapolelo (2005) observed that this constraint had led teachers to adopt teacher-centred strategies like *teach-example-exercise.* Textbooks and past examination papers become major resources for teaching mathematics. As a result, learning mathematics is mainly through memorisation and drills.

With regard to classroom practice, Isahak et al. (2008) found that seventy percent of primary school students could barely comprehend their teachers' teaching of mathematics in English, while eighty-five percent reported that their teachers used code switching. During interviews, the teachers admitted using code switching as a strategy to ensure students' understanding. However, the researchers felt that in some cases this could have been an indication of teachers' lack of proficiency in English.

This section has described the implementation of the teaching of mathematics and science in English and its challenges. In the next section, the professional development programme implemented in Malaysia specifically to support teachers for this initiative will be discussed.

3.5. Professional Development.

In Section 3.4, it was suggested that teaching mathematics in second language is a demanding task for the teachers. Therefore, it is imperative to have professional development programme, which support the teachers ability to cope with the challenges. This section discusses the professional development programme designed specifically for teaching of mathematics and science in English in Malaysia, English for the Teaching of Mathematics and Science (ETeMS). In order to provide some guidelines to evaluate the effectiveness of the ETeMS training programme the characteristics of effective professional development are outlined first.

Professional development comprises activities teachers engage in to improve their professional knowledge, skills and attitudes to enable them to educate their students more effectively (Bolam, 1987). Traditionally, professional development includes presentations, coursework and workshops, aimed at enhancing teachers' knowledge and skills (Loucks-Horsely, 1995). However, in recent years, professional development has shifted focus from individual growth to building organizational cultures and support systems for teachers' development (Avalos, 2011). Thus, professional development now includes activities such as coaching, mentoring and study groups (Garet, Porter, Desimone, Birman, & Yoon, 2001). In fact, informal activities like reading a professional publication or even viewing a television programme on a specific academic discipline are considered as professional development (Ganser, 2000).

Guskey (2002) saw professional development programmes as systematic efforts to bring about changes in classroom practices of the teachers, in their attitudes and beliefs, and in the learning outcomes of students. He argued that the sequence in which these

changes occur is also important. Based on this assumption, he proposed an alternative model of teacher change contrary to the traditional model described by Loucks-Horsely, (1995). He stipulated that change in teachers' attitude and beliefs would only come after they have gained evidence of improvements in students' learning. This is because teachers' beliefs are based on what works best in their classrooms.

What are the factors that affect a teacher's decision to change? Guskey and Sparks (1991) provided three criteria for a teacher's decision to use any innovation in teaching. First, the ideas or new practices should be clearly presented to them. Second, teachers look for how well the new idea aligns with their current philosophy and practices. The third criterion is cost, that is, the teacher estimates the time and the effort that the new practice requires compared with the benefits the new practice would bring.

According to Guskey (2002), however, there are three principles of teacher change. First, change is a gradual and difficult process for teachers. This is supported by Carroll (2003) who stated that teachers can and do change their practice, but to varying degrees over time. Secondly, Carroll noted that teachers need to get regular feedback on students' learning. A successful outcome serves as reinforcement for teachers to sustain the newly acquired skill. Third, Carroll says it is crucial to provide continuous follow-up, support and pressure to teachers to facilitate their development. In other words, professional development should be seen as a process, and not an event (Loucks-Horsley et al., 1996). Ongoing support is essential for teachers to cope with the changes, while pressure is an occasional nudging that teachers require to help them persist in the challenging tasks related to making changes in their teaching (Guskey, 2002).

3.5.1. Effective professional development.

As stated earlier, teachers play an important role in the implementation of any education reforms. The success of education reform initiatives depends mainly on the qualifications and effectiveness of the teachers (Garet et al., 2001). Thus, professional development programmes should be a major focus in the implementation of education reform. Researchers in this field have identified various features of effective professional development. In this section, four research studies on professional development are examined, Garet et al. (2001), Guskey (2003), Ingvarson, Meiers and Beavis (2005) and Louck-Horsely et al. (1996): as a means to identify the characteristics of effective professional development programmes.

Guskey (2003), drawing on articles from *Journal of Staff Development,* journal on teacher education in the United States of America conducted a meta-analysis to identify the characteristics of effective professional development. Guskey's analysis found, the most cited criteria for effective professional development are those that focus on the enhancement of teachers' content and pedagogical knowledge. It is very important for the teacher in order to teach well, to be knowledgeable in his or her own subject matter as well as in the way the students learn. In another meta-analysis, Loucks-Horsley et al. (1996) reviewed a variety of standard and related materials for the best professional development in mathematics and science education. Their findings concurred with those of Guskey as they concluded that effective professional development provides opportunities for teachers to develop their knowledge of subject matter and broaden their

teaching approaches. This then enables teachers to facilitate students' learning. Results from surveys conducted by Garet et al. (2001) in the United States of America and Ingvarson et al. (2005) in Australia also lend supports to these views.

Another important characteristic of effective professional development is the promotion of collegiality and collaborative exchange among participants (Guskey, 2003; Louck-Horsley, 1996). Teachers of the same subjects need to work together in order to reflect on their instructional practices, exchange ideas and share strategies among themselves. This helps strengthen the learning community. Ingvarson et al. (2005) specially recommended examining of students' work collaboratively. They suggested that doing this leads teachers to reflect on their practice and gain feedback about their teaching from colleagues.

The next criterion in regard to effective professional development that the researchers agree upon is that effective professional development must include continuous evaluation of the programmes (Louck-Horsley, 1996; Guskey, 2003). In fact, Guskey (1991) suggested that evaluation of a professional development programme should begin during planning and continue throughout all phases of its implementation. This evaluation is important for further improvement of the professional development programme and development of follow-up courses.

Guskey (2003) also mentioned provision of sufficient time as a criterion for effective professional development. Guskey concluded that the time must be "well organised, carefully structured and purposely directed" (p. 749). In addition, as Garet et al. (2001) also found, time span and contact hours both have a positive influence on the opportunities for active learning. Ingvarson et al. (2005) agreed

that time and contact hours are important in the design of effective professional development activities.

One interesting feature listed by Louck-Horsley et al. (1996) was that the instructional methods of effective professional development that promote learning for adults should mirror the methods to be used with the students. An example of this is teachers should be allowed to have hands on experience rather than just memorising knowledge that is already known. Similarly, Garet et al. (2001) and Ingvarson et al. (2005) agreed that professional development should provide teachers with opportunities for active learning and those opportunities should reflect the teaching and learning strategies that the professional development programme is recommending to teachers to implement in their own classrooms.

The last characteristic that all the researchers agreed upon is that professional development should provide links with other reform efforts. This would help teachers to better understand the context surrounding the reform and the standards and "initiatives that come to them from other levels of education system" (Louck-Horsley et al., 1996, p. 5).

While checking the quality of professional development programmes against these criteria may be a straightforward exercise, it is the combination of how they are interwoven into any programme that will determine and influence the programme's success. As Guskey (2003) points out "the characteristics that influence the effectiveness of professional development are multiple and highly complex" (p. 750) and furthermore, the variety in context will produce different results.

So far, a number of criteria for effective professional development have been discussed. In the next section, professional development in teaching mathematics in a second language is described.

3.5.2. Professional development in teaching mathematics in a second language.

Despite the fact that teaching mathematics in a second language is a common practice, few studies have focused on the influence or the role that teacher professional development can play in supporting teachers who teach content areas in a second language. Janzen (2008) reviewed a body of literature on teaching specific content areas to second language learners. It was taken from the data based on topics of English Language Limited Speaker (ELLS) mostly in the United States of America, Canada and Austria. She found none of them focused specifically on the challenges of working with second language learners and teacher training. Lucas et al. (2008) added to this by saying that although there was a body of literature which discussed the knowledge and pedagogical competence that teachers should have in teaching content areas to second language learners, "It has not made its way into teacher training programmes. Among the reasons for this is that these publications use linguistic approaches and terminology that can be challenging, for those inexperienced in linguistic analysis" (p. 362). In their review, Lucas et al. (2008) concluded that to assist the second language learners in learning specific subjects teachers need to have three types of pedagogical expertise:

- familiarity with students' linguistic and academic backgrounds;

- an understanding of language demands inherent in the learning tasks that students are expected to carry out in class; and
- skills for using appropriate scaffolding so that students can participate successfully in those tasks.

From the above list, it is clear that teachers need to have special language-related knowledge, such as knowledge of the second language acquisition theories listed in Section 2.4., to understand the students' linguistic background. In conclusion, Lucas et al. (2008) recommended that knowledge of second language acquisition be incorporated into teacher professional development programmes. This suggestion is useful in the case of Malaysia in order for the teacher to assess the students' level of language proficiency which in turn helps them to plan the lessons that cater for the particular needs of the students. However, there is another area in which the teachers need support and that is, in improving their own language proficiency to teach in their second language.

Feryok (2007) agreed that few studies have investigated how content teachers learn to deal with the language needs of their learners. She described a professional development programme, which exposed content teachers to the principles and methods of teaching English to speakers of other languages (TESOL), using a task-based language teaching approach. She explained that presenting the teachers with these principles would raise their awareness about "the value of exploiting the language learning potential of what they were already doing as well as offering new techniques" (p. 7). The participants for this programme were twenty-five mathematics and science teacher trainers from

Malaysia. At the end of the ten-week programme, the researcher found that, in general, the participants were able to understand the reason behind the use of a task-based language teaching approach, which is to promote language use through interaction. Specifically, eighty-eight percent of the participants felt that this course was useful, as it provided a practical option which could be incorporated into the existing curriculum, and, more importantly, it enhanced their confidence in using English. Back in Malaysia, these participants delivered a five -day pilot in-service workshop to one hundred teachers of mathematics and science. Formal anonymous evaluation from the participants showed that the programme was useful especially in building their confidence to teach their subjects in English.

The most important point raised by the articles reviewed by Janzen (2008) and Lucas et al (2008) is the need for professional development, which exposes the mathematics teachers to the principles of language teaching and learning. Besides providing teachers with opportunities to develop their understanding of the challenges faced by their students, effective professional development programmes for supporting second language learners facilitate teachers' ability to make instructional adaptations to accommodate specific learner needs.

3.5.3. Professional development for the implementation of teaching of mathematics and science in English.

The previous section provided an overview of critical areas of focus in professional development in teaching of mathematics and other content areas in a second language. It was noted that not many research studies focused on the in-service training of the teachers who are teaching content areas in a second

language. In this section, the professional development programme, ETeMS is described and the characteristics of effective professional development presented earlier in Section 3.5.1 are used to examine its effectiveness. While this research study did not focus specifically on professional development, the information about the ETeMs training programme helps provide an insight into the factors that shaped the classroom practice of the teachers observed in this study.

In general, professional development in Malaysia is mainly planned and conducted by the Ministry of Education, and takes the form of short-term courses or in-service training. Outcomes are generally far from satisfactory (Hussein, 1990; Foong, 2004). In the field of mathematics, Lim and Wun (2003) surveyed 124 mathematics teachers and found that one third of them had not attended any in-service training except for ETeMS, in the previous five years. Their interviews with the teachers revealed that many of them found it difficult to implement new knowledge or skills because of large class sizes and lack of appropriate equipment like a graphic calculator. Furthermore, many teachers felt that they were forced to attend the courses.

ETeMS is perhaps the largest in-service training project that has occurred in Malaysia (Foong, 2004). It was designed specifically to enhance English language proficiency among mathematics and science teachers so that they would be able to teach their subjects in English. There are three parts to the ETeMS training programme. First there is instruction through face-to-face interaction. Second, self-instructional packages are provided to schools and teachers and third, there is a

Buddy System programme, which provides continuous support to mathematics and science teachers after they have attended the course.

Ninety hours of the course involves instruction delivered through face-to-face interactions. This interactive phase consists of two parts. First, five modules are delivered over a period of five weeks. Each module requires two days of interaction. Second is a five-day module. For the first five modules, teachers have to attend a two-day course during the weekend. It is mostly done at the resource centre at each district. For the five-day module, teachers stay at a selected training venue, normally a hotel, so that the training session can be done the whole day without any interruption. Each two-day module consists of a series of sessions covering a total of twelve hours interaction. Among the activities carried out are text labs, during which teachers develop their text-processing skills and language-labs, in which teachers are given the opportunities to develop their language competence for classroom use. Each session focuses on a specific skill (e.g. explaining concepts). Teachers are also given the opportunity to practise the skills they have learnt through classroom simulation activities. At the end of each module, teachers reflect on their learning experience and set their personal goals. During the five-day module, teachers further develop their language skills as well as developing actual lesson plans. The scripted lesson plans produced by the teachers contribute to the development of a Bank of Scripted Lesson Plans. Besides developing the plans, teachers also practise using the scripted lessons with their peers. The self-instructional package includes a set of materials for self-

improvement, a set of grammar books and dictionaries with CD-ROM (Foong, 2004).

According to Gill, Nambiar, Ibrahim & Tan (2009), the theoretical underpinnings of ETeMS training programme rested on the development of content knowledge based on language acquisition theories developed by Cummins (1979, 1980). These theories were discussed in Section 2.4. The principle underlying Cummins's (1979) Developmental Interdependence Hypothesis is that older learners are able to transfer the academic skills they had acquired in their first language to the learning of similar skills in second language. Hence, the teachers can utilise their content knowledge and skills in mathematics to increase their English language proficiency.

3.6. Research in the use of English for Teaching of Mathematics and Science (ETeMS) in Malaysia.

Since its implementation in 2003, there has been a number of research studies carried out on the use of ETeM. The studies focused on some of the issues of the implementation of ETeMS including teachers' perspectives on the policy change and the effects of the training programme (Hafiz et al., 2006; Noraini et al., 2007; Pandian & Ramiah, 2004), teachers' level of confidence to teach in English (Hamidah, Nordin, Isa, Puteh, Muhammad & Majid, 2005; Noraini et al., 2007; Ong & Tan, 2008), teachers' English language competency (Isahak et al., 2008; Ong & Tan, 2008; Sam et al., 2009) and the teaching strategies used in teaching mathematics and science in English (Isahak et al., 2008; Nursherrina, 2005; Ong &Tan, 2008; Pang, 2005).

Several studies have been carried out to measure the effectiveness of ETeMS. Pandian and Ramiah (2004) conducted a survey of eighty-eight science and mathematics teachers who had undergone the ETeMS training. The results showed that seventy-six percent of the teachers agreed with the policy change and seventy-five percent felt confident that they would be able to cope with the change. This study also came up with two important findings regarding the language aspects. First, eighty-one percent of the teachers admitted to using their first language when explaining difficult concepts to students. Second, while seventy percent of the teachers were aware of the difference between everyday language and specific mathematics register, they were not clear about the linguistic features of their subject content.

Similarly Noraini et al. (2007) conducted a survey of seventy-two mathematics and science teachers and found that majority of the respondents, eighty-two percent, agreed that the ETeMS programme had prepared them to speak English, while ninety percent felt that they were able to understand reading materials in English. However, the teachers felt they needed further training to write instructional materials and construct test items in English. They also identified the need for strategies to deal with students who were weak in English.

Hafiz et al. (2006) attempted to measure the ETeMS training programme by looking at the input, process, product and impact. They found that the input was suitable and effective to attain the course objective. However, there was the need to improve the course modules, for example, teachers who were weak in English needed to have different and simplified modules. In terms of process, participants felt that the trainers conducted the training programme effectively but the duration was too short. The study

showed that the course succeeded in fulfilling the needs of the teachers. For impact, the findings showed that teachers were still lacking confidence to contribute to their school in terms of conducting in-house training for their colleagues.

Hamidah et al. (2005) investigated a similar issue of teachers' confidence through a nationwide survey involving 575 teachers. Their findings were similar to the findings cited earlier, that teachers generally felt confident to teach in English and that the ETeMS training course helped them to improve their command of English.

Research on teachers' classroom practice, however, produced contradicting results with regard to teachers' confidence levels. Ong and Tan (2008) conducted classroom observations and interviews with mathematics and science teachers. They found that in general the teachers were confident but in practice some of them were still struggling to teach in English. Ong and Tan concluded that there were three main factors which had salient impact on teachers' transition into teaching in English. They were: the teachers' prior education background; the linguistics environment in schools; and the linguistics ability of their students. Ong and Tan found that teachers who had experienced their own education in English could easily teach in English. Support from other teachers and administrators in the schools was also important as well as having students who were competent in English. Ong and Tan also found that teachers were inclined to use translation and code switching especially when the students were weak in English.

In looking at teaching strategies, Nursherrina (2005) observed that teachers made necessary preparation for the lessons, but none of the research participants were aware of mathematics register. The use of teaching courseware provided by the Curriculum Development Centre was also investigated. Sam et al. (2009) found that the teachers

seldom made use of this resource because the language used was too difficult especially for the students with low levels of proficiency. They added that some new teachers were having difficulties explaining the contents of the courseware to their students, hence, they were discouraged from using the resource provided. They also raised the point that the courseware contained mainly content presentation and some drill-and-practice exercises. These types of activity were not helpful in promoting students' thinking ability and mathematical reasoning.

Pang (2005) conducted a study in schools in Sabah. He identified several factors which supported the implementation of ETeMS. Among them were the direct involvements of the school administrators including the principals, the increase in the supply of resources which would help in building item bank and teaching modules, and the increase in monitoring strategies by the Ministry of Education.

Gill et al. (2009) examined the implementation of the ETeMS training programme and listed a number of challenges: varying levels of language proficiency among teachers; compressed scheduling of the in-service training; lack of post training networking; under-utilisation of self-instructional materials; and less successful collaboration among teachers. Gill et al. suggested that teachers' reluctance to use the materials could be related to their lack of proficiency in English.

First, the mathematics and science teachers who attended the ETeMS course had varying levels of English competency. Some senior teachers might have been trained in English, but they had been teaching in Bahasa Malaysia, not in English. The younger teachers had been trained fully in Bahasa Malaysia resulting in difficulties with teaching mathematics in English (Sam et al., 2009). Kamsilawati's (2005) survey among trainee

teachers showed that they were struggling to learn the specific terms in English as well as having to familiarise themselves with the new language of instruction.

The second challenge was related to the scheduling of the training programme. The schedule for the course was compressed in order to avoid disruption to the students and schools. The provision of sufficient time is important for effective professional development as suggested by several researchers (Garet et al., 2009; Guskey, 2003; Ingvarson et al., 2005) in Section 3.5.1. One of the implications of the shorter course duration was lack of opportunity for hands-on learning by the teachers. This could also be regarded as a setback since Louck-Horsely et al. (1996) suggested that a hands-on activities strategy is more effective in professional development courses than presentation and memorisation of knowledge.

Conducting a nationwide professional programme which involved a large number of participants was not easy. There were bound to be some coordination problems. On top of this, the expectation that the language policy was to be implemented immediately did not give the course coordinators a lot of time for planning. For example, the coordinators had to work with a set of assumptions regarding teachers' level of language proficiency and professional needs because there was not enough time to carry out a nationwide needs analysis (Pillay & Thomas, 2003).

Another issue raised by Malaysian researchers regarding the ETeMS professional development was the lack of post training networking among teachers (Gill et al., 2009; Khiruddin, 2007). The ETeMS programme was a one-time event (Ong & Tan, 2008), and there was lack of opportunity for teachers to share their experiences and improve on their teaching after the course (Gill et al., 2009). In terms of collaboration between

mathematics and science teachers with English teachers, it was relatively unsuccessful because of time constraints and heavy workloads. More importantly, the English teachers felt they were not able to assist in translating specific mathematics terms owing to their lack of knowledge of the content area (Khiruddin, 2007). Guskey (2003) advocated the promotion of collegiality and collaboration among participants as one way of reflecting on instructional practice. This criterion for effective professional development could not be carried out through a one-off training programme such as ETeMS training, despite the in-built Buddy System and the self-instruction materials, both of which were supposed to aid in teachers' longer term learning and development.

Where the self-instruction materials were concerned many teachers felt they were burdensome to read, especially when they already had heavy workloads at their schools (Khiruddin, 2007).

This section described the professional development programme for ETeMS in Malaysia. Some of the challenges in the implementation were also discussed using the guidelines for effective professional development discussed in session 3.5.1. Despite the fact that there were a number of problems with its implementation, in general this training programme was successful in giving the teachers some linguistics skills to teach their subjects in a second language. After all, ETeMS training programme was an interim measure taken to help teachers to begin teaching in English.

3.7. Conclusion.

This chapter provided information on the Malaysian education system, which served as the backdrop for this research. The implementation of ETeMS training

programme was described with reference to several criteria for effective professional development. Lastly, this chapter presented a review of a number of studies conducted in this field.

In conclusion, the ETeMS training programme was discussed and evidence was presented about the success of the programme in helping large number of mathematics and science teachers in Malaysia to teach in English. However, studies reported suggested a need for follow up courses which focus on specific problems that have arisen from the implementation of ETeMS, including how to teach students who are weak in English. More important, the studies argued that teachers need to be further supported to improve their English language proficiency.

CHAPTER FOUR

METHODOLOGY

4.0. Introduction.

In this chapter the research design is discussed. In particular, the method adopted for the research is described, together with the process for selection of the participants, the research procedures, and the data analysis process. The chapter ends with discussion on ethics and research validity.

4.1. Language in Mathematics.

In a multiracial and multilingual country like Malaysia, the use of a second language for teaching is always an important educational issue. It was noted in Chapter Three, that the language education policy in Malaysia in regard to teaching mathematics has changed three times. The change in language of instruction has created a new field of research in multilingual Malaysian education. This research was situated in that context.

Language is being increasingly recognised as important in mathematics education. The assumption is that learning involves communication, and language is an essential tool for communication. This assumption raises the questions of how mathematics

concepts are developed and how language factors affect the flow of mathematics ideas in the classroom especially in a second language setting.

Vygotsky's (1962) Social Development Theory of Learning posits that teachers play an important role in students' academic and language development. This theory is supported by several studies in the teaching of mathematics in a second language described in Chapter Two. The studies showed that in a second language classroom, students rely heavily on their teacher for language input and support (Khisty & Chval, 2002; Meaney, 2002; White, 2003). A teacher should serve as a role model as a competent speaker of English and good user of mathematics register, as well as determining the patterns of communication in the classroom (Setati et al., 2002). Hence, teaching mathematics in a second language poses challenges for the teachers.

Based on the theory and previous studies presented in this thesis, this study aimed to examine the mathematics teachers' classroom discourse in order to gain a deeper understanding of the issue of teaching of mathematics in a second language. Three specific questions were posed:

- What was the nature of the use of mathematics register by teachers in teaching mathematics in English?
- How did the teachers explain mathematics concepts and develop them in their lesson using second language instruction?
- Did the teachers use specific teaching strategies in teaching mathematics? If they did, when did this occur?

While the most recent language policy in Malaysia means the teaching of mathematics will revert to Bahasa Malaysia, it is hoped that this research can still

contribute to the field of teaching of mathematics in a second language. In line with this research focus, the research design was chosen.

4.2. Research Design and Method.

Patton (2002) stated that there is no specific recipe or formula in making research method decisions. However, there are a number of factors that can be considered. Among the factors to be considered is the purpose of the inquiry. Since this study aimed to gain an in-depth understanding of an educational issue, which was teaching of mathematics in a second language, a qualitative research approach was chosen.

According to Fraenkel and Wallen (2009), a qualitative approach is used by researchers who "are more interested in the quality of a particular activity than in how often it occurs or how it would otherwise be evaluated" (p. 423). A qualitative approach to research is based on the view that individuals interact with their social worlds to construct reality (Merriam, 1998 b). People's perception of the world is manifested in their behaviour. Qualitative methods such as participant observation will give researchers access to individual meaning in the context of ongoing daily life (Burns, 1994). In fact, one of the strengths of qualitative methods in educational research is that they "can highlight subtleties in pupils' behaviour and response, illuminate reason for action and provide in-depth information on teacher interpretation and teaching style" (p. 14).

For this study, the researcher used qualitative methods to look into the interaction between the teacher and the students in a natural setting, the classroom, in order to gain a better understanding about teaching of mathematics in a second language. Specifically, a

case study approach was chosen because this study focused on the specific context of teaching mathematics in Malaysian primary schools.

A case study is defined as "a detailed examination of a setting or a single subject, a single depository of document or particular event" (Bogdan & Biklen, 2003, p. 60). Case study researchers are interested in examining a particular case in order to gain an in-depth understanding of a certain phenomenon in a real-life context. A case does not necessarily refer to an individual or an object; rather it includes events, activities and even processes. In this research, the classroom discourse of four mathematics teachers was observed in order to gain understanding of how the teachers taught mathematics in a second language.

One of the distinctive features of case studies is that they are particularistic (Merriam, 1998a). This feature refers to the specific focus of the study. An in-depth study of a specific instance can illuminate a general issue. Yet, the case study approach is often criticised for providing little basis for generalisation. Yin (2003), however, argued that the purpose of case study research is to generalise the findings to a theoretical proposition, and not to a population as occurs as an outcome of statistical research. In the case of this research, the finding might not be true for all teachers teaching mathematics in a second language, but it could shed some light on the general issues of teaching mathematics in any multilingual classroom. Furthermore, it was not the main goal of this research to make generalisations, instead, the research sought only to provide in-depth understanding of the issue at hand.

Two other important features of case studies are that they are descriptive and that they are heuristic. Unlike the product of a quantitative study, which was often presented

as statistical summation, a case study report is normally highly descriptive. Description is particularly useful especially to practitioners (Burns, 1994). An ordinary teacher, for example, may be able to understand the descriptive style of presentation more than sophisticated measurement techniques. Thus, the findings may lead to an improvement in teaching practice. Heuristic means a case study illuminates the readers' understanding of a phenomenon through discovery of new meaning, extension of the readers' experience, or confirmation of what is learnt (Merriam, 1998a). The heuristic nature of this study was related to the process of discovering teachers' discourse patterns in teaching mathematics in a second language.

Yin (2003) made the distinction between two major types of case study designs: single-case, which focuses on one case and multiple-case that focuses on more than one case. Yin stated that analytic conclusions, which rose from two or more cases, were more powerful than only if one case was studied, thus enhancing the validity of the findings. Similarly, Fraenkel and Wallen (2009) stated that "the results of multiple case studies are often considered more compelling and they are more likely to lend themselves to valid generalisation" (p. 431). For this research, the researcher decided to study the classroom discourse of four mathematics teachers in Malaysia. This decision was made to enable the researcher to make comparison of the teachers' classroom practice. While there were four different participants, the observations made on each of them were used in generating the data to address the same research questions. Furthermore, the use of four cases added richness to the data collected, enabling more valid conclusions to be made. It was intended that the description of their practice will contribute to the understanding of teaching mathematics in second language.

4.3. Research Instrument.

Having identified a suitable research design, the data gathering methods were chosen. This study utilised two main data gathering methods, namely, participant observation and semi-structured interviews.

4.3.1. Participant observation.

Observation is the process of gathering first-hand information by observing people and places at a research site (Creswell, 2007). Participant observation refers to the process of studying people's activities in a natural setting (Kawulich, 2005). This method is central to a qualitative approach as it, "serves to elicit from people their definition of reality and the organising constructs of their world" (Burns, 1994, p. 260). Among the advantages of this method is that the researcher has the opportunity to record information as it occurs in a natural setting and it enables the researcher to gain an insight into the participants' interpersonal behaviours and motives (Yin, 2003).

In this study, observation of four mathematics teachers who were currently teaching in two primary schools in Malaysia was undertaken. The observation assisted the researcher in gaining an understanding of teachers' use of language in teaching mathematics in a second language.

One of the major concerns in observation is the role of the researcher during the observation. The role played by the researcher during the observation can have different effects on the data. The role of a researcher can vary from a complete

participant to a complete observer (Johnson & Christenson, 2004). A researcher may assume a primary role but he or she may play a different role at different times or in different situations. The role varies according to how comfortable the researcher is with the situation, the rapport he or she is able to build with the participants and the researcher's judgement on the best way to collect the data (Creswell, 2007). For this study, the researcher took the stance of observer as participant. Basically, the researcher's participation in the group was as a means for conducting better observation and generating more complete understanding of the group's activities (Kawulich, 2005). In this study, the researcher visited the sites and recorded the lessons without becoming involved in the activities of the participants.

As stated earlier, the researcher observed four mathematics teachers teaching in two primary schools in Malaysia. Each teacher was observed teaching the same class for a week (approximately 140 minutes). The lessons were videotaped and stored digitally on DVDs for analysis. In addition, the researcher also recorded field notes. The notes provided supplementary information on what was going on in the classes during the lessons. The field notes also contained the researcher's reflections on the events.

The decision to use video recording as a data-gathering tool was made for several reasons. First, it gave access to a rich source of information regarding what went on in the mathematics classrooms as it picked up details that might have gone unnoticed (Griffee, 2005). The focus for this research was to examine the teachers' classroom discourse, therefore video recording helped record the speech as well as

the action of the participants. Without the recordings, it would have been difficult for the researcher and the teachers to recall what the teachers had said verbatim. Second, videotaping allowed the capture of significant moments in classroom interaction as it was impossible for the researcher and the teachers to recall all the details of the lessons. Furthermore, the video recording produced a permanent record, which could be viewed repeatedly in a variety of ways, for example, it could be played in slow motion, forward or backwards. This allowed for a more thorough and complete analysis to be made of the data collected and increased the validity of this observation method (Hollingworth, 2003). The use of video recording was important for this research, not only because it could be played back and viewed many times but also because it could be viewed by the teachers. The recording of the lessons was used as stimulus for the stimulated recall session with the teachers.

However, there is a drawback to the use of video recordings as the video camera could be intrusive to the students and teachers in the classroom. This could have resulted in recordings not representing a typical behaviour. In order to minimise the effect of this intrusion, the participants were informed, well ahead of the observation schedule and procedure. The researcher also visited the school prior to the observation sessions to carry out mock observations to familiarise the students and teachers with his tasks in their classrooms.

4.3.2. Semi-structured interview.

Another method used for data collection in this research was semi-structured interviews. This method was used to complement the classroom

observation. The interviews added more information to the findings as the interview was conducted to clarify the teachers' choice of classroom discourse, from the teachers' points of view. The interview schedules for the pre-observation interview appears in Appendix 1. Details about the interviews held as part of the stimulated recall sessions appear in section 4.6.3. Interviews are often used as a data gathering tool as they provide the opportunity for a researcher to elicit specific information from the participants (David & Sutton, 2004). Structure refers to the form of and order of questions which are kept identical for all participants. This study made use of semi-structured interviews as it gave more freedom to the participants to voice their opinion and reflections than the structured interview but at the same time, it gave the researcher some control over the topics being discussed. One of the advantages of a semi-structured interview is that the questions are flexible and open-ended in nature, thus giving the participants a fair amount of freedom to decide on what to say, and how much to say, and how to express it (Wallace, 1998). Different types of questions were used to gather information from the participants. The *core questions* were the main questions which addressed the key themes of the research while *prompts* were used to elicit additional information (David & Sutton, 2004). In order to clarify the meaning of certain responses, *clarifying questions* were also asked of participants. The use of all these types of questions was important, not only to add to the richness of the data, but also to increase validity of the research findings.

For this study, interviews were conducted before and after the classroom observations. A pre-observation interview sample, provided in Appendix 2, shows

how information was sought about the participants' backgrounds, as well as their general perceptions of teaching mathematics and their language preferences. Besides obtaining this information, the researcher also used the interview to build rapport with participants. The second set of interviews, which were in form of stimulated recall, was carried out with each teacher after each lesson observation was completed. This meant that during the period of data gathering, each participant was interviewed four times, once before the observation, then three times, one after each classroom observation.

4.3.3. Stimulated Recall.

The stimulated recall method is an introspective method which emphasises the reflection of the participants' mental processes. Basically, this method refers to a reflective exercise, in which the participants comment on the activity they were engaged in earlier. According to Gass and Mackey (2000), the stimulated recall method can be used to prompt participants to recall thoughts they had while performing a task or participating in an event. Rowe (2009) pointed out that stimulated recall provides the participants with the opportunity to view events from an outsider's perspective but with the insider's sight into their motivation and intention. In this study, stimulated recall was used to explore the teachers' thought processes by asking them to reflect on their thoughts when specific teaching strategies were being employed during a recorded lesson.

The quality of the data collection procedure for stimulated recall depends on three main characteristics: (a) the stimulus; (b) the duration between the event and recall; and (c) the instrument used for collecting data. The stimulus is used to

refresh the recollection of cognitive processes and can be videotapes, audiotapes, written products or a combination of any of them. The stimulus should be strong enough to reactivate recall (Gass & Mackey, 2000). In this research, the stimulus used was the video recording of the lessons, allowing the participants to revisit and reflect on the events (Rowe, 2009)

The time between the event and the recall session is important because it determines the amount of information that the participants can remember. Consecutive recall or immediate recall is recommended because the participants might recall better right after completing a task (Gass & Mackey, 2000). In this research, the stimulated recall sessions were held after each observation was completed. This was done in order to avoid the participants getting the lessons mixed up. This arrangement can be seen in the research activity schedule (Appendix 1).

Lastly, the instrument used for collecting data also contributes to the quality of data gathered. The instrument used can vary from one that is highly structured, for example, making use of pre-determined questions, to one that has little structure including for example, a structure similar to that of an open interview. The instrument used for eliciting information in this research was the semi-structured interview. Details about these semi-structured interviews used within the stimulated recall sessions can be found in section 4.6.3.

4.4. Research Setting.

The research was conducted in two primary schools in Malaysia. The first school was situated in the south of peninsular Malaysia, in a place that was once a fishing village, but has developed rapidly, partly due to its close proximity to Singapore. The school is situated in the town and was categorised as an urban school by the Malaysian Ministry of Education. The majority of the students came from middle class working families. There were approximately one thousand two hundred students in the school, comprised mainly of Malays, followed by Chinese and Indians.

The second school is located in the northern state, which is close to Thailand's border. It was considered a rural school by the Malaysian Ministry of Education. It had about eight hundred students and the students mostly came from lower class working families. Almost all the students were Malays.

4.5. Selection of Participants.

Qualitative researchers identify the participants and sites based on places and people that can best help them in understanding the central phenomenon. This is known as purposeful sampling (Creswell, 2007). Merriam (1998b) stated that "purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which most can be learned" (p. 61).

In addition, a case study often involves two levels of sampling. First, a case is selected, and then sampling is done within the case. Another characteristic of qualitative sampling is that it normally involves a small number of participants compared with

quantitative sampling. This is to allow in-depth studies to be carried out in a situation (Fraenkel & Wallen, 2009).

There are different types of purposeful sampling. For this study, the researcher chose an homogeneous sample selection. This involved selecting individuals or settings based on membership in a subgroup that has defining characteristics (Creswell, 2007).

Following the case study method of sampling, a case was selected, which was teaching mathematics in Malaysia. Then, participants were selected based on set criteria. The two main criteria were first, that the participant must be teaching mathematics in a Malaysian primary school, and second, that they must have undergone the ETeMS training programme. In order to narrow the scope of this research, participants were selected from two primary schools, in two different areas, the urban and rural part of Malaysia. This allowed for comparison to be made among teachers who teach in different contexts. During the process of selecting the participants, the principal of each school was consulted for suggestions of teachers who might want to be involved in the study. This was necessary as the principals knew their teachers best and took into consideration the time constraint as well as the teachers' workload before making their suggestions.

Based on the selection process described above, four teachers were chosen from two different schools. The demographic data about each teacher was collected during the pre-observation interview. Prior to the interview, a list of questions was given to participants (Appendix 2). The information presented in this section is based on the participants' written answers as well as the answers they gave during the interview. Participants were asked questions pertaining to their personal and educational backgrounds.

All four participants were female teachers. They were Malays, which means they spoke Malay as their first language. Professionally, all of the teachers were trained in Teacher Training Colleges in Malaysia. They each had obtained a Diploma in Teaching Mathematics. One of the teachers had recently obtained a Bachelor degree from one of Malaysian Universities. All participants were trained in Bahasa Malaysia, the national language used as the language of instruction in the Malaysian education system. All participants had also undergone the ETeMS training programme which was conducted nation-wide in 2003.

The section that follows presents information about each teacher. In order to protect the anonymity of the teachers, each of them has been identified by her pseudonym: Amirah, Aisyah, Amni and Aryana.

Amirah was 30 years old and had 9 years teaching experience. She attended the ETeMS course in March 2003. In general, she found this professional development useful but she felt that the issue of teachers' confidence should be addressed more through practicum or mock teaching. She enjoyed teaching mathematics but thought that language was a barrier for effective classroom communication. Her class consisted of eleven year-old students who were mostly Malay (twenty-four), Chinese (seven) and Indian (three). Amirah taught in an urban school.

Aisyah taught in the same urban school as Amirah. Aisyah was slightly younger than Amirah (twenty-eight years old) and had been teaching mathematics for seven years. She attended the same course as Amirah. She felt that the ETeMS professional development was very useful as it presented teachers with a lot of language input. However, she thought that teachers should be given more time to practice teaching

mathematics in English. She found that it was challenging to explain mathematics concepts in English. She taught a Year Four class, which was made up of ten year-old students. The class consisted of twenty-three Malays, four Chinese and two Indians.

Amni taught in the other school in a rural area. She was forty-six years old and had twenty-three years teaching experience. She attended the ETeMS course in early 2003. During the interview, she said that she had gained a lot from the professional development especially in the language aspects. Similar to the other teachers, she felt that the issue of teachers' confidence was not fully addressed during the training. While she enjoyed teaching mathematics, using English made her uncomfortable in class. For her, it would take a longer time to explain mathematics concepts in English than in Bahasa Malaysia. She taught Year Four students (ten years old) and her students were all Malays.

Aryana was 36 years old and had been teaching for fifteen years. She had just obtained a Bachelor's degree from one of the universities in Malaysia through a distance learning programme. She also attended the nationwide ETeMS course in 2003. She raised similar issues to the other teachers regarding the professional development they had attended. The course provided a lot of language input but a lack of practice did not help much in developing her confidence in the classroom. She also voiced her concern about weaker students, whom she felt would not benefit from learning mathematics in a second language. She thought that a separate course should be conducted to address the problem. She admitted that she did not have much problem teaching in English but was afraid that her students would not understand her if she used only English in the class. Aryana taught a younger group of students, nine year-olds, in the rural school. All her students shared the same mother tongue, Malay.

4.6. Research Procedures.

All research conducted in Malaysia has to go through the Economic Planning Unit (EPU), a subdivision of the Prime Minister's Department; for approval. The unit issues a researcher's pass, which allows the researcher access to most government offices and schools. For the current study, the researcher applied for permission to carry out research in Malaysia and was given permission to do so for the duration of three years. In conducting this research, the researcher was aware of financial and time constraints because the distance between Malaysia and New Zealand is far. Therefore, the researcher planned the research schedule carefully to make the most of the data collection time. The schools were identified and the researcher had informal meetings with both principals. The principals of the schools gave their consent for the research to be conducted. They suggested the names of teachers on their staff who would be willing to participate. Both principals suggested that the observation be carried out in Year Three and Year Four classrooms as these students were not involved in any major examination.

There were three main parts to the data collection. They were: a pre-observation interview; classroom observation; and, stimulated recall sessions. Prior to the actual data collection process, the researcher visited each school to meet with the principal, the mathematics teachers and the students involved. The teachers and students were briefed separately and given the information sheet (Appendices 4 & 5) and consent form after they had volunteered to participate (Appendices 6& 7). The teachers and students were informed of the purpose of the research, the schedule and the procedures. They were advised of their rights when they agreed to participate. The teachers understood that this

study was not carried out to evaluate them, but to share knowledge and help in improving the teaching of mathematics in a second language in Malaysia. The students and their parents were informed that the students were not the direct focus of the study. The process of data collection began after the consent from both parties was obtained. Most of the time, the briefing to the students was done in Bahasa Malaysia, to ensure that everybody understood their rights.

In both of the schools where this research was conducted, the researcher was given a room to be used as an office. The room was equipped with a DVD player and a television. The pre-observation interviews and stimulated recall sessions were held in this room while the observations were conducted in the teachers' classrooms. The three parts of the data collection process are now described in more detail.

4.6.1. Pre-observation interview.

For the pre-observation interview, the researcher met with each teacher. Each teacher was asked questions about her personal and teaching background, and general perceptions about teaching mathematics. The intention of this session was to build rapport between the researcher and the participants, so, these interview sessions were not recorded. Prior to the interview, the participants were asked some "warm up" questions to gather some information on their background (Appendix 2).

The participants were allowed to take home the list of questions and they brought it back for the interview. In order to make the participants feel at ease, they were given the choice of answering the questions in either Bahasa Malaysia (L1) or

English (L2). It was interesting to note that all of the teachers answered mostly in English. Since the sessions were not recorded, the researcher added notes to the answers the teachers had written. The interview session with each teacher lasted about ten to fifteen minutes.

4.6.2. Classroom observation.

The second part of data collection process was classroom observation. Before conducting the observations, the researcher had obtained each participant's timetable and discussed with her a suitable time to observe. The researcher also went into the class and carried out mock observation sessions to familiarise the students with the presence of the video camera and the researcher. This was to minimise the effect of the intrusion caused by the researcher and his video camera. For classroom observations, each teacher was videotaped teaching three lessons (approximately 120 minutes). With the exception of one lesson which was carried out in an audio-visual room, all lessons were carried out in the classrooms. The physical setting of the classrooms, which is typical of a Malaysian classroom, is presented in Figure 4.3.

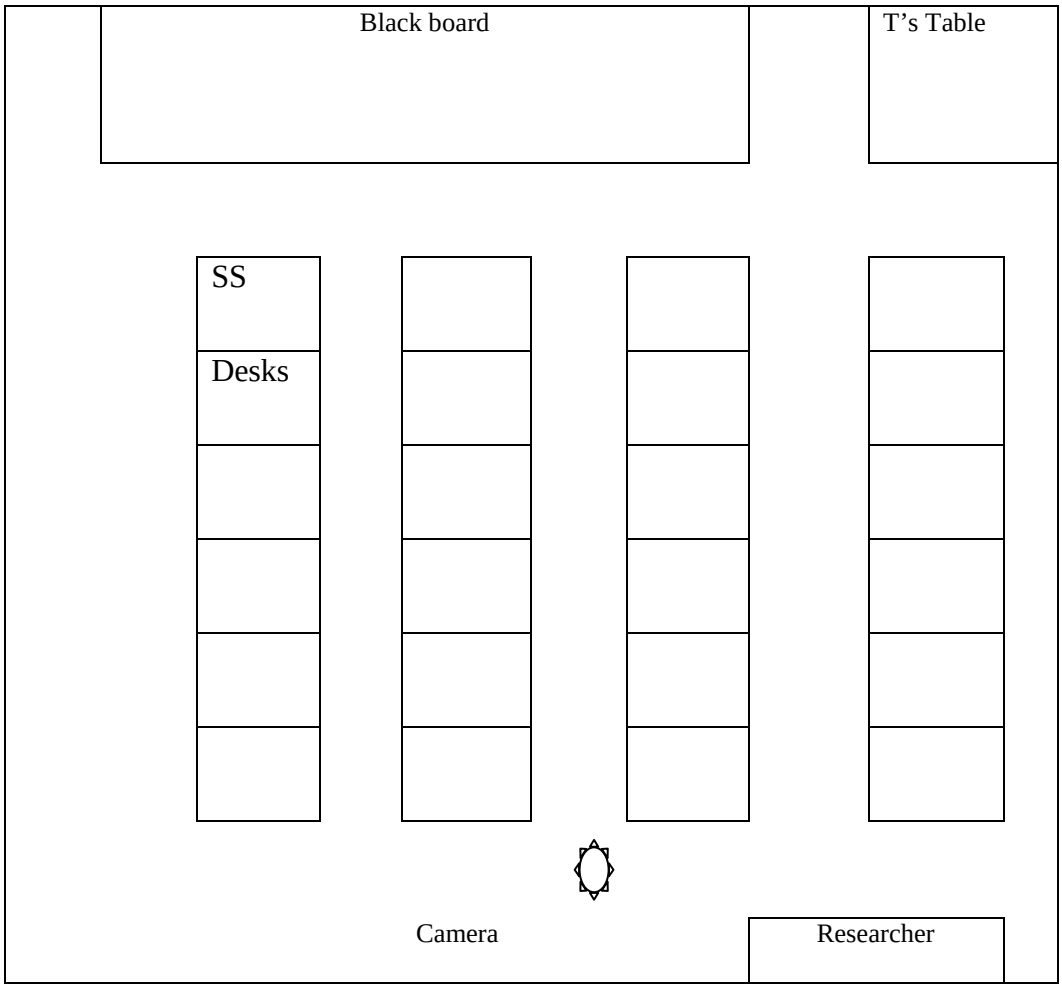


Figure 4.3.

The physical setting of the classrooms.

As illustrated in Figure 4.3 above, the camera was placed at the back of the class and aimed mainly at the teacher since she was the focus of this research. Placing the camera at the back of the class also helped to minimise obstruction. During the observation, the researcher assumed the role of a complete observer. It also allowed the researcher to adjust the camera from time to time while making notes. More importantly, it minimised interruption to the lessons.

There were, however, a few limitations to this method of data collection. There were instances where the quality of the recordings was not clear. Although

the video camera was put on a tripod to allow the researcher to make notes, at times, there was the need to change the angle as the teacher moved from one end of the class to another. There were also problems with external noises such as voices from students outside the classroom, noises from the nearby construction sites, sound of traffic from a nearby road and at one time, the sound of heavy rain. Fortunately, these disruptions only lasted for a short time.

The video recordings were used as the stimulus for the next part of data collection: the stimulated recall session. After each video-recorded session, the researcher viewed the lesson and identified the key parts based on these criteria which were drawn from the literature as discussed in Chapter Two:

- teacher's use of mathematics register;
- teacher's expansion of mathematics concepts; and
- teacher's use of specific teaching strategies.

The parts were marked and used later as stimuli in stimulated recall sessions.

4.6.3. Stimulated recall.

As discussed earlier, it is recommended that researchers minimise the time delay between events and recall (Gass & Mackey, 2000). Therefore a time was sought that was as close to the observation as possible, yet fitted in with the teachers' schedule. Hence, each stimulated recall sessions was carried out within one or two days of the observation.

During the session, the teacher and the researcher watched the recording together. The researcher gave the following instructions to the teacher:

- Please view the tape carefully. Identify the parts of the lesson which you

felt were the most successful and least successful.

- You may stop the tape at any time.

There was no set criterion for the most successful and least successful parts of a lesson. They are based on the teachers' own judgement. However, the researcher expected the teachers to justify their claims. After the teacher had identified the parts, the researcher replayed each part and asked the teacher to explain the reasons behind the occurrences recorded on the video. Focus was upon the teachers' use of language. For example, questions included:

- You have asked the students to repeat after you. Why?
- Why do you choose to use L1 for this part?
- Can you remember what were you thinking when you said this word?

These subordinate questions are also known as probes (Gass & Mackey, 2000). Probes and prompts were used here to encourage the teacher to provide more information and assist them to recall the lesson. Lyle (2003), in his review of literature on stimulated recall, identified these criteria as best practice of stimulated recall techniques.

> It is necessary to reduce anxiety; limit the perception of judgement probing; reduce the intrusion into the action; stimulate rather than present a novel perspective/insight; make the retrospection as immediate as possible; allow the subject a relatively unstructured response; and employed an 'indirect' route to the focus of the research. (pp. 865-866)

In his attempt to reduce the amount of anxiety among the participants, the researcher gave the teachers the freedom to answer the questions in the language

that they were most comfortable with, upon their request. The use of second language can affect the content of the recall as it limits the participants' ability to express themselves and may involve a lot of interpretation and assumption on the part of the researcher. David and Sutton (2004) stated that language is the key to the interview and that "it is essential that questions be asked in a language that the interviewee can make sense of, and which is understood in the same sense that the interviewer intended" (p. 88). Since the researcher shared the same first language with all the participants, translating from one language to another was not a problem. These sessions were audio-recorded for further analysis. In order to familiarise the participants with the technique, the researcher gave them the same task for all the three sessions, which was to identify the strongest and the weakest parts of the lesson. The researcher found this practice helpful because by the third sessions, the teachers' answers were getting longer and richer. Each stimulus recall session lasted between forty-five minutes to an hour. The teachers' responses were transcribed and analysed.

4.6.4. Field notes.

In a qualitative research approach, the researcher needs to be self-reflective, and able to keep track of events related to the methods, procedures and the evolving analysis (Bogdan & Biklen, 2007). For this study, reflexivity was documented through field notes. Field notes are "the written accounts of what the researcher hears, sees, experiences and thinks in the course of collecting and reflecting on the data in a qualitative study" (p. 119). For this study, the researcher took field notes during the observation session as well as after viewing the recordings.

The researcher decided to combine the field notes and transcriptions to assist in the process of analysing, comparing and contrasting the entities that emerged in the data. The sample of transcription and field notes of one of Amirah's lessons is shown in Appendix 3.

4.7. Ethical Consideration.

For this research, a number of measures were taken in regard to the ethical issues related to this study. The teachers who took part in this study were informed about the research including the aims, the procedures and how the results were going to be used. As indicated earlier, each participant was given an information sheet (Appendix 4). The researcher assured them that this research was not carried out to evaluate their teaching styles or their language proficiency. Rather, their effort would yield a valuable contribution to the studies on teaching mathematics in a second language. In addition, since the study would require the participants to contribute a considerable amount of time especially in the stimulated recall sessions, it was essential that they were willing to commit time and effort freely. It was decided from the beginning that their involvement in this study would be on a voluntary basis. Bogdan and Biklen (2007) had raised the issue of participants feeling *coerced* to participate in order to please the researcher or obtain some form of personal gain. The participants were made well aware that their involvement would not have any bearing on their annual performance report.

Regarding the issue of anonymity, Bogdan and Biklen (2007) stressed that the participants' identities should be protected so as the information collected would not run the risk of embarrassing or harming them in any way. This issue was addressed in this

study by keeping the anonymity of participants at all time. In writing of lesson transcripts as well as interview transcripts, the teachers were identified using pseudonyms. The data collected were treated with confidentiality. The researcher assured the participants that the videotapes would not be seen by others.

While the teachers were the main focus of this study, the students were also indirectly involved in the study. Some of their comments are used to highlight certain points in the findings. Therefore, the students too were informed of the research, its objective and procedures. Since they were all children, their parents were given an information sheet (Appendix 5). The information sheet was in English and Bahasa Malaysia to ensure understanding of the research that was going to take place in the classroom. Consent was obtained from the parents for each child before the data collection phase began (Appendix 7). The children's identities were protected in a similar way to their teachers'.

4.8. Research Validity.

Validity refers to "the extent to which a question or variable reflects the concept the researcher is looking for" (Davidson & Tolich, 1999, p. 32). In other words, the methods chosen for the research should be able to provide the answer to the issue being investigated. Morse et al. (2002) stressed the importance of methodological coherence to ensure emergence between the research question and the components of the method. It is crucial that "the research questions match the method, which in turn matches the data and analytic procedure" (p. 12). Earlier in this chapter, the research aim and questions were highlighted and links were made to the choice of method. It was argued that the multiple

case study approach was appropriate for developing an understanding of the issue being investigated.

While there are contradictory views on the terms reliability and validity pertaining to the qualitative paradigm (Morse et al., 2002), there is a certain standard needed to ensure the quality and credibility of a qualitative research. Davidson and Tolich (1999) said that, “the strength of quantitative research lies in its reliability, while the strength of qualitative research lies in its validity” (p. 34). This means that, while qualitative results may not be able to be generalised to other location, the results accurately reflect the perspectives of the participants. Provision should be made to ensure the trustworthiness of the research. Merriam (1998b) likened the process of rendering credibility to a qualitative study to an auditor checking a business account:

> Just as an auditor authenticates the accounts of a business, independent judges can authenticate the findings of a study by following trails of the researcher. In order for audit to take place, the investigator must describe in detail how data were collected, how categories were derived, and how decisions were made through the inquiry. (p. 172)

So far, the researcher has provided the audit trail of this study by discussing in detail the methodological aspects of the study and methods of data collecting. Relevant documents are presented in the Appendices. In this section, the steps that were to be taken to ensure the credibility of this research study are presented.

The validity of a research study can be strengthened through triangulation. Triangulation involves using multiple sources of data or multiple methods to confirm the emerging findings (Merriam, 1998b). There are different types of triangulation: data

triangulation; method triangulation, and researcher triangulation. A strategy of using different methods to gather the data is known as method triangulation. For this research two different methods, classroom observation and semi-structured interview were chosen. In addition, field notes were taken to add more details to the data. The use of these methods is common among qualitative researchers because the methods complement each other (Johnson & Christenson, 2004). Another strategy that is used to maximise the validity of the data collected is data triangulation. This refers to the use of multiple data sources from a single method (Creswell, 2005). For example, in this research, the researcher obtained two data sources, video recordings of lessons and field notes, from the classroom observation method. The field notes provided more description of what was going on during the lesson. The researcher also conducted unstructured interviews with the teachers to support the data that he observed in the video recordings.

Another feature of data triangulation is that it can involve collecting data at different times, at different places and with different participants (Johnson & Christenson, 2004). In this case, the sources refer to the different participants and sites. For this research, the researcher observed four different teachers at two different schools. The idea was that, through the rich information gathered, more in-depth understanding on the issue of teaching mathematics in second language would be developed.

Another related area is how to ensure the interpretive validity of the data collected. This refers to the extent to which the researcher accurately interprets the participants' viewpoints, thoughts, feelings, intentions and experiences (Johnson & Christenson, 2004). In order to achieve interpretive validity, in this study the researcher used two strategies. The first one was the use of low-inference descriptors. "Verbatim is

the lowest inference descriptors of all because the participants' exact words are provided in direct quotation" (p. 100). In most parts of this report, the researcher has used participants' exact words as transcribed from the video. This includes the participants' usage of the teachers' first language. Translation is provided to assist readers' understanding.

Another verification strategy outlined by Morse et al. (2002), and used in this research, was to collect and analyse data concurrently. It is suggested that qualitative research is iterative, in that researcher should "move back and forth between design and implementation to ensure congruence among question formulation, literature, recruitment, data collection strategies, and analysis" (p. 10). The fact that each participant was observed three times provided the researcher with opportunities to reflect on what had been done and to take the appropriate steps to improve the data collection procedure. This repeated process also served as some kind of recruitment for the participants, so that they would be familiar with what would be asked of them. The participants were also asked to provide feedback on the results obtained in the previous sessions.

The data collection process for this research took approximately two and a half months. The researcher spent one month at each school, getting familiar with the setting and the participants as well as conducting the research. This allowed the researcher to obtain information that was more detailed and to test any assumption and assertions the researcher was making on the issue being investigated.

Another issue of concern related to this research was translation. English was used for most of the research. However, the information sheet given to parents of the students and the briefing to the students were in Bahasa Malaysia. This was to ensure that the

students and their parents were clear about the research. The teachers were given the choice to answer interview questions in any language that they were comfortable using, and all of them answered in English. All the translation involved in this research was done by the researcher. The researcher had the same first language (Bahasa Malaysia) as all the teachers (participants) and had his elementary and secondary education in Bahasa Malaysia. He then continued his studies in Canada for five years and became an English as a Second Language (ESL) teacher for fifteen years in Malaysia. It was felt that the researcher's education background and working experience would qualify him to translate the materials for this research. However, to address the issue of research validity, the researcher showed the translated materials to the participants. In terms of the presentation of the data, the researcher used the original form of the speech used by the participants including the L1 materials. Translation was provided below the actual utterance.

4.9. Data Analysis.

Data collected from this research consisted of twelve video recordings of the lessons, audio recordings of the stimulated recall sessions and artefacts such as teachers' answers to questions about personal background, field notes, lists of students' names (taken from enrolment data from the school offices) and worksheets provided to the students by the teachers. However, the researcher could not obtain the software used by the teachers as a teaching resource because of copyright issues.

4.9.1. Transcribing.

The recording of each lesson was transcribed by the researcher. The researcher also transcribed the recording of the stimulated recall sessions. During and following the transcribing process, the researcher carried out documentation of events and ideas as part of the reflective process.

4.9.2. Coding the data.

The analysis of the data involved detecting major themes and subcategories of each theme. For analysing the teachers' discourse, Setati's (2005) categories of classroom discourse, described in Chapter Two were used. The reason for using these categories was because they have been widely used in the mathematics research of discursive practice (e.g. Khisty, 2000; Setati & Adler, 2000; Van Oers, 2001) and enabled the researcher to relate the finding of this research to other research in this field.

Besides describing the discourse categories, this researcher was also exploring the teaching strategies derived from the teachers' discourse practice. Since code switching was identified as a common practice in teaching of mathematics as a second language (Farrugia, 2006; Setati, 2005), it was useful to identify the instances where teachers used first and second languages. So, for each discourse category, the languages used by the teachers were also described. The categories for analysis described in this section are summarised in Figure 4.

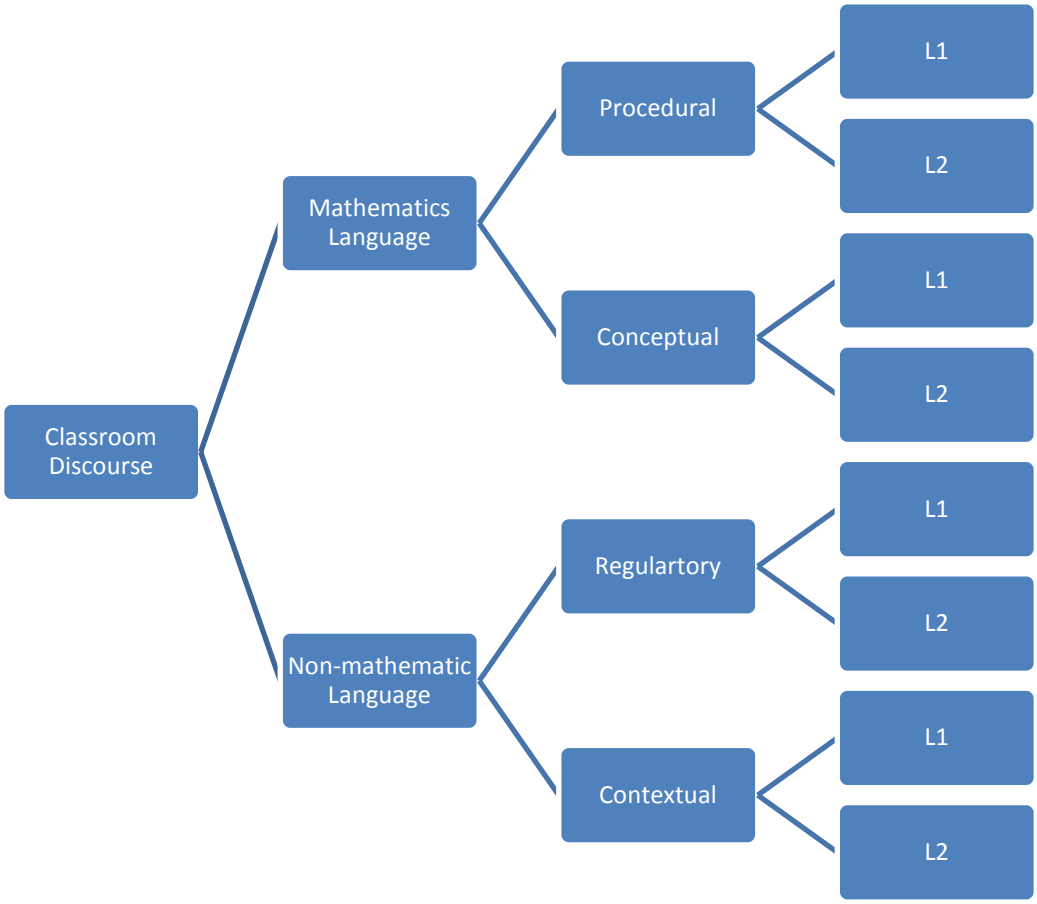


Figure 4.

Categories for data analysis

The task of counting the occurrence of each discourse category was done with the help of computer software, NVivo. The software counted the number of times each example of discourse category was used by each teacher. NVivo also enabled the researcher to count the utterances made in L1 and L2. The tables presenting the percentage of use for the example of discourse category and languages in Chapter Four were developed with the help of this software. The numbers used in data presentation were not intended as a frequency count as in statistical analysis, rather, they were a device for identification of the emergent trends found in this data. The percentages and numbers presented in this report are used mainly to facilitate discussion of findings.

Besides analysing the discourse used by the teachers during classroom observation, the teachers' responses in the stimulated recall sessions were also analysed. These responses given by the teachers were used to support their language during the observed lessons.

4.10. Conclusion.

This Chapter discussed the research approach taken to investigate the issue of teaching mathematics in a second language. The research design and research instrument were outlined and the data collection procedures were reported. Lastly, the methods used to analyse the data, which led to the findings presented in the next chapter, were discussed.

CHAPTER FIVE

RESEARCH FINDINGS

5.1. The Nature of Mathematics Teachers' Classroom Discourse.

This research set out to investigate the nature of the use of a second language in the teaching of mathematics by primary school teachers in Malaysia. The main source of data was from classroom observations. The classroom observation data were supported by semi-structured interviews with the teachers. In the previous chapter, the data collection procedures and methods of data analysis were discussed. The findings of this research are presented in this chapter and Chapter Six. Chapter Five deals specifically with categories of classroom discourse that emerged from the data gathered. These categories that emerged are discussed in the light of the literature in Chapter Two, particularly in association with ideas developed by Setati (2005). The first part of Chapter Five begins with an explanation of each category with examples from these data. The average percentages of usage for each category are also discussed. The presentation of the percentages focuses attention on the patterns that emerged from the teacher talk. Interview and observation data, combined with the numerical data enabled richer insights to be made into the language decisions made by teachers and their associated teaching practices than consideration of the numerical data alone. The language related strategies used by the teacher participants in teaching mathematics in the classroom were also

examined. In doing this, Meaney's (2002) Mathematics Register Acquisition Model was used as a frame for the discussion as it provided a list of strategies used at different stages of mathematics register acquisition with which the observed actions of the participants in the study were compared. In Chapter Six, the focus is on code switching (Setati, 2005) and on errors made by teachers in using the second language.

5.2. Mathematics Language and Non-Mathematics Language.

During the process of identifying mathematics language, the definition and characteristics of mathematics register outlined in Chapter Two were used. The relationship between mathematics language and non-mathematics language is complex (Moschovich, 2005). Mathematics language can involve the use of the same words as the non-mathematics language but those words may carry different meanings. Therefore, the context of the utterance becomes very important. The main data collection method for this study was classroom observation, whereby teachers were observed teaching in a natural teaching environment. The uses of video recordings as well as the field notes helped identify the contexts for teachers' utterances in this study.

Setati (2005) identified two main categories of mathematical discourse within the classrooms that she studied: mathematics discourse and non-mathematics discourse. These categories are further divided into four subcategories: Procedural, Conceptual, Regulatory and Contextual Discourses. These categories became the bases for discourse analysis of the data with an extension being made to the definitions to include some of the other examples in the data that did not emerge from Setati's studies. In analysing the observation transcripts, the utterances made by the teachers were divided into stanzas for

easy referencing in the discussion. Each stanza was made up of a group of utterances that dealt with the same unitary topic or with topic that were related to each other. Extracts from the video taken of each teacher's lessons are used to illustrate points made in the discussion that follow. References to the transcript number and to the relevant stanza appear in parentheses after each quotation.

5.2.1. Procedural discourse.

Procedural discourse is the discourse used by the teacher in explaining the steps taken in doing mathematics computation. This type of discourse normally occurs without the presence of any reasoning for such calculation.

Procedural discourse was prevalent when teachers were working on calculation with the students. This can be seen in the example below when Amirah was calculating the perimeter of a rectangle with the whole class.

Amirah: Let's check the answer for this one

What number must you plus here?

30 cm, next...30cm okay, plus 26 cm and another one 26cm

So, the final answer is 112, what? ...112 cm.

(Transcript 1, stanza 7)

In this example, Amirah wrote down the numbers on the board and went through the steps in adding the numbers to get the perimeter of the shape. This was done without providing any reasons for the steps taken. This was a typical example of procedural discourse which occurred in the lessons observed. There were several times when the teachers were involved in demonstrating mathematics computation with their students.

Another example of procedural discourse was when the teacher was showing her students how to measure an object properly. Although this procedure did not involve any calculation, it could still be regarded as a procedural discourse because it involved discussion of the steps taken in measuring the object. This example was taken from one of Aisyah's lessons.

Aisyah: Okay, now look

(Showing a paper clip to the class)

How many lengths the papers clip?

First, make sure you start from zero mark to…

Twelve

Awak kena kira dari nombor kosong ataupun sifar sampailah yang terakhir,

Nombor dua belas

Kira dia punya jarak

(*Count the length, from zero to twelve. You measure*)

One, two, three, four, five, six seven, eight, nine ten, eleven, twelve

So, the length of a paper clip is, 12mm.

(Transcript 3, stanza 45)

In this example, Aisyah showed her students how to measure the paper clip using a ruler. She made sure the students started counting from zero. Again, no reason was provided for doing that. Aisyah also used both English and Bahasa Malaysia (L1) in her explanation.

The third example showing that procedural discourse was being used by the teacher in her explanation of how to draw a diagram. This example was taken from Aryana's lesson.

Aryana: Okay class

First, semicircle

How to draw semicircle

Okay, use your ruler

Firstly, draw the straight line

Class, all of you do this, finish?

Okay, ready

Start from here, put your pencil here

Then turn and draw

Buka, turn right, *tutup*

(*open*, turn right, *close*)

Class, you finish?

(Transcript 8, stanza 191)

In this example, Aryana demonstrated to her students how to draw a semicircle. She used L1 to describe the movement of the pencil. This example was also included in the procedural discourse category because it involved the teacher explaining steps taken in drawing a two dimensional mathematics diagram.

The three instances given above are representative of the procedural discourses observed. Setati's (2005) definition has been extended here to include not only discourses which involved calculation, but also other situations whereby

the teachers explained procedures in mathematics such as in the examples from Aisyah's and Aryana's lessons above.

5.2.2. Conceptual discourse.

Another of Setati's subcategories in mathematics discourse is conceptual discourse which refers to discourse used by teachers to provide reasons for choosing a specific method of computation. In a similar way to the previous category, for this category the researcher extended the definition of conceptual discourse to include any utterances made by the teachers in their attempts to explain mathematics concepts and also to provide reasons for making certain calculations. One instance of conceptual discourse is shown in the following excerpt from Amni's lesson:

Amni: Six kg, convert to gram

Why 6000?

6 times 1000, because 1 kg equals 1000g

So, the answer is 6000g

(Transcript 7, stanza 165)

In this example, Amni was showing the class how to convert a kilogram to grams. She went on to explain why students should multiply by 1000 in their conversion.

Another example of conceptual discourse can be seen in this excerpt from Amirah's lesson.

Amirah: Okay, tell me what is this shape?

(Pointing to a square on the blackboard)

Students: Square

Amirah: Why do you say this is a square?

Students: Because (it) has four sides

Amirah: Can you repeat? Four?

Students: Four equal sides

Amirah : Yes, Four equal sides

Sides *ialah sisi*

One, two, three, four sides

This is a square because it has four equal sides

Empat sisi yang sama

(Transcript 1, stanza 2)

Amirah was checking to make sure that her students could identify the shape. She also offered her own explanation of why the diagram was a square both in English and Bahasa Malaysia.

Similarly, in the example that follows, Amirah was making sure her students understood the concept of a perimeter before moving on to show them how to calculate the perimeter of a shape.

Amirah: When you want to find the total of all sides, you must plus all the sides

Aah..ialah sisi or edges

So, this way we call (how) to find perimeter

Understand?

When you plus all the sides, this way we find perimeter.

(Transcript 1, stanza 9)

Amirah showed her students that one of the ways to find a perimeter is by adding the length of all the sides. In this section, examples of conceptual discourse have been presented and described as it occurred during the classroom observation.

5.2.3. Regulatory discourse.

Regulatory discourse is non-mathematics discourse. It is commonly used by teachers to regulate students' behaviour in classrooms. During the observations made in this study, this type of discourse was often observed at the beginning of the lesson when the teachers were getting the students ready for their work. It was also seen when teachers were assigning tasks to the students or controlling the class.

Below is an example of regulatory discourse taken from Amni's lesson when she was preparing the students for the day's lesson.

Amni: Good morning class

Today, we are going to learn about measurement and mass

This is a weighing scale.

(Showing the weighing scale to the class)

Teacher want to show (you how) to measure, understand?

(Transcript 5, stanza 116)

In the above excerpt, Amni began her lesson by greeting the students and telling them the topic for the lesson. She also referred to the weighing scale that she had brought to class. In this example, regulatory discourse was used to prepare the student for the topic that they were going to learn.

In the next example, Amirah began her lesson in a slightly different way. Since it was the second lesson of the week, she started her lesson by checking her students' homework.

Amirah: Let's see this activity sheet

If you (have) not finished do…

Oh, one person go and get the exercise books from my table in the staff room.

(Transcript 2, stanza 25)

In the example, Amirah used regulatory discourse to make sure the students were ready to check the answers for their homework. Sometimes, regulatory discourse was also used in controlling disruptive behaviour the class.

Amirah: Look here

Jangan sampai saya marah

(*Don't make me angry*)

Sit down properly,

Tengok depan

(*Look in front*)

(Transcript 2, stanza 34)

In the example, Amirah scolded a few students who were talking among themselves at the back of the class. In controlling the students' disruptive behaviour, Amirah used English and Bahasa Malaysia.

In another instance, Amirah was checking her students' homework and she found that a few of them had not done it. This is the dialogue between them:

Amirah: Ha, why didn't you do your homework?

Student: *Lupa (I forgot)*

Amirah: *Oh, lupa? Bagus lah*

(*You forgot? Good*)

That's a very good reason.

(Transcript 2, stanza 26)

5.2.4. Contextual discourse.

Contextual discourse is a non-mathematics discourse which is used to explain the context of a mathematics word problem. It is important to help the students understand the task and answer the question. While none of the examples that follow deal with a word problem, the utterances made by the teachers were categorised as contextual discourse because they involved explaining the questions to the students. Similar to regulatory discourse, teachers used L1 in explaining the context of the question, often relating it to students' experience. For example, Amni tried to explain to her students about the digital weighing scale:

Amni : For example, you go to Tesco you see the digital one

You know, digital weight scale

You put cabbage, 2 kg

2.00 kg, this is the digital number

Kamu akan lihat berbeza-beza

(*You will find different types of weighing scale*).

(Transcript 5, stanza 130)

In the example, Amni gave the name of a supermarket (known to the students), Tesco, as a place where they might see a digital weighing scale. Amni had brought different weighing scales to show her students. In this way, Amni created a familiar context for thinking about weighing scales and finding the weight of objects.

In another example, Aisyah was trying to explain the meaning of the word *thickness* to her students.

Aisyah: You must measure and record the thickness of a book.

What is the meaning of thickness?

Ketebalan buku awak

(*Thickness of your book*)

(Transcript 3, stanza 63)

In her attempt to help the students understand the question, Aisyah used Bahasa Malaysia and at the same time she also held up the book to class. In this example, the contextual discourse was in L1.

In the next example, Aryana was giving tips to her students on how to memorise the name of a diagram.

Aryana: Okay, hexagon, how many sides?

Six

(She wrote the word six on the board)

Tengok abjad ini

(*Look at this letter*)

Abjad here 'x' ada tak 'x' kat sini

(*See, the letter 'x' is in the word six and also in 'hexagon'*)

So, hexagon has six sides

(Transcript 9, stanza 207)

In this example, Aryana showed her students how to remember the name of the diagram and the number of sides it has making references to something the students would be sure to notice in future, that is, both the words *hexagon* and *six* have the letter *x* in them. Similarly to Aisyah, Aryana also reverted to L1 when explaining complex concept to her students.

In this section, the occurrences of contextual discourse in the data were discussed It was noticeable that teachers used more of the L1 for this type of discourse. The issue of language used by teachers will be further discussed in the next chapter.

5.2.5. Summary of discourse analysis.

In this section, the patterns that emerged from discourse analysis of the teachers' lessons are discussed. This is done with the help of Table 5.2, below, which summarises the average percentage of discourse categories used by the teachers.

Table 5.2:

Average Percentage of Discourse Categories Used in Teaching Mathematics.

	Regulatory	Procedural	Contextual	Conceptual
Average %	30	43	7	20

In this study, procedural discourse seemed to dominate most of the teachers' discourse. Analysis of the data revealed that on average forty-three percent of the teachers' utterances fell into this category (see Table 5.2). The reason is that almost all the lessons observed followed the same structure: the teacher presented the topic and explained the concepts; the teacher showed a few examples of how to answer the questions based on the topic covered; the teacher assigned the tasks; and the teacher checked the answers with the class. By following this structure, most of the time during the lesson was spent on demonstrating the calculation. Setati and Adler (2000), in their study of discourse in a teacher's mathematic lessons also found that procedural discourse was the most dominant feature of the lessons. They attributed this finding to the fact that the teacher's focus was normally on students mastering the procedures, not the reasoning. This seemed also to be the case in the classrooms observed in the current study. The teachers in this study used more procedural discourse and it can be seen in the teacher's lesson plan (Doc. 3b) and the teacher's test question (Doc. 7a).

First, the objectives of the lessons, as recorded in Amni's written lesson plans, did not specify that students needed to explain the reasons for the computation they made. This learning objective was taken from Amni's lesson plan which was used for her lesson on Measurement and Mass:

Learning objective:

6.1.3. Add, subtract, multiply and divide units of mass

(Doc. 3b)

In Malaysia, the teachers refer to the Curriculum Specification distributed by Ministry of Education when writing the learning objectives. This way, the learning objectives are standardised throughout the nation. The number (6.1.3) refers to the Curriculum Specification. In line with the objective stated above, the assessment for this topic also did not require students to give a reason for their answers; they only needed to give the correct answer.

The test questions on the same topic *Mass* also seemed to encourage the frequent use of procedural discourse by the teachers. The following illustrates this:

Section B: Answer the following questions

2kg 500g + 1 kg 700g = _____

4kg + 800g =_____

(Doc. 7a)

The example above was taken from the quiz questions for Amni's class. It is evident that students were not required to give any reasons. This test question also mirrored the examination questions that students are presented with for this learning unit. It could be argued that the type of questions reflected the procedural nature of mathematics and therefore sent a message to learners that procedural discourse is the discourse of assessment. As a consequence this emphasis on procedural discourse could then suggest to students that conceptual discourse is unimportant (Setati, 2005). The percentage of usage for conceptual discourse was twenty percent (see Table 5.2). This indicates that teachers explained mathematics concepts or calculation methods less often in comparison with all other types of

language used. As stated earlier, the reason for this may have been that students are not required to give reasons for their calculations.

The second discourse category that was frequently used by the teachers in this study was regulatory discourse. Table 5.2 showed that thirty percent of the teachers' verbal interactions with the students were from this category. Teachers tended to use regulatory discourse at the beginning of the lessons to prepare the students for the lessons, to make sure the students understood the tasks and to control disruptive behaviours.

Lastly, the percentage of usage for contextual discourse was seven percent. One explanation for the low level of usage in comparison with the use of other categorises of discourse could be that none of the lessons dealt with word problems. Questions seemed to be regarded as straightforward by students and did not require further clarification by the teachers. In Section 5.2.1showed students' answers, that provided evidence to support this claim. Students only needed to give answers without explaining how they obtained them.

This section discussed the use of the different discourse categories throughout the lessons observed. The pattern that emerged showed that procedural discourse was the most frequently used by teachers in the study. This was followed by regulatory discourse, conceptual discourse and lastly, contextual discourse. While the literature on the teaching of mathematics in a second language encourages the use of conceptual discourse because it refines students' understanding of mathematics, it was not the case in the lessons observed during this study that conceptual discourse was highly used. Some possible reasons for this

situation are provided in the next section. The use of these discourse categories by the individual teachers who participated in the study will be discussed.

5.3. Individual Teacher's Discourse.

In this study, four teachers from two different schools were observed teaching mathematics for one week. Within this one week, each teacher taught five lessons. Two lessons for each teacher were selected and are described in detail in this section. The lessons chosen were made up of an introductory lesson on a new topic and one other follow-up lesson. The introductory lesson was chosen because teachers normally introduce new concepts during this lesson. The follow-up lesson which was selected illustrated the multiple discourses at work in one lesson. In this section, each teacher's discourse practice in these lessons will be described and the use of L1 and L2 by each teacher will be indicated. Further discussion of the teachers' discourse practice will be presented in Chapter Six. Table 5.3 below shows the use of different discourses by each teacher in each lesson.

Table 5.3**:**

Percentages of Discourse Categories Used by Four Teachers.

Teacher	Lesson	Regulatory	Procedural	Contextual	Conceptual
Amirah	1	9 %	46 %	0 %	45 %
	2	48 %	24 %	1 %	27 %
Aisyah	1	22 %	48 %	15 %	15 %
	2	50 %	13 %	4 %	33 %
Amni	1	17 %	48 %	8 %	27 %
	2	19 %	67 %	2 %	12 %
Aryana	1	45 %	52 %	0 %	3 %
	2	47 %	31 %	10 %	12 %

5.3.1. Amirah.

Amirah was teaching Year Four (ten year old) students the topic ‘Perimeter of shapes’. She began her class with revision of the multiplication table, using regulatory discourse at the beginning of her lesson, calling out the names of the students to answer her questions. Then she proceeded with the new topic by showing different shapes to her students. She asked students to explain how they could recognise each shape:

Amirah: Okay, what do you call this shape?

Students: Square

Amirah: Are you sure?

Students: Yes

Amirah: Why do you say this is a square?

Students: Because it has 4 sides

(Transcript 1, stanza 2)

This activity was repeated in the same way for a rectangle and triangle. In this activity, conceptual discourse was observed when the teacher asked for explanation about how students would recognise each shape. Sometimes, she offered her own explanation to help her students understand better. This was done in both English and Bahasa Malaysia.

Amirah: Why do you say this is a rectangle, not the square?

(Silence)

This shape still has four sides but...

What is the difference here?

(Pointing to the sides)

Ha... two long sides, here...

What about the other, these two sides?

Students: Short

Amirah: Two short sides, we call this rectangle

(Transcript 1, stanza 3)

After this, the teacher showed her students how to draw and measure each side of the shapes. Then, she proceeded with explanation of how to find perimeters of different shapes. Most of the time, only procedural discourse was used by Amirah. English was used mostly with procedural discourse. Bahasa Malaysia was used when she wanted to explain something to her students and it was only limited

to one or two word utterances, such as *sisi* which was translated directly from the English word *sides*.

Amirah wrote a few questions on the board for her students to answer. Before asking them to answer the questions, she explained the procedures to follow again, this time fully in L1.

Amirah: Okay make sure you know the meaning of perimeter

Keseluruhan, luar sahaja, ukur lilit, ukur keliling

(*The total of the outside edges, perimeter*)

(Transcript 1, stanza 18)

Both the Bahasa Malaysia words *ukur lilit* and *ukur keliling* mean perimeter in English. After giving time for the students to complete the tasks, she called a few students to do the exercise on the board. Regulatory discourse was used by the teacher to give encouragement to individual students who attempted to answer the questions she gave.

Amirah: Ha, What is your final answer?

Student: 48 cm

Amirah: How do you get that?

Student: Times six

Amirah: Yes, because you have six sides

Very good

(Transcript 1, stanza 21)

This example was taken from Amirah's interaction with a student who was writing her answer on the blackboard. Interestingly, the whole dialogue between them was in English, when both of them actually share the same L1.

Amirah ended her lesson by presenting a few questions for students to do at home. In this lesson, as shown in Table 5.3, there was a balanced use of procedural discourse (forty-six percent) and conceptual discourse (forty-five percent). Since this was the first lesson for this topic, the teacher provided explanations and gave sample questions for students to practice. Only nine percent of regulatory discourse was observed, mainly at the beginning of the lesson, when students were getting ready for the lesson and at the end when the teacher gave homework to the students.

Amirah began her second lesson by checking the students' homework. A few students were called to the front to write answers. Meanwhile, she moved around the class, identifying those who had not done their homework. She scolded these students in L1. In this beginning part of the lesson, a lot of regulatory discourse was used.

Amirah: Buat correction, diagram you don't draw.

Hah, just write the correct answer

Do like this

(Pointing to the blackboard)

Cakap orang tak nak dengar

(*Why don't you listen to me?)*

Okay, finish?

(Transcript 2, stanza 28)

In this example, Amirah used regulatory discourse to make sure her students' mistakes were corrected. She used English for most of the interaction but reverted to Bahasa Malaysia when she scolded one of the students. As soon as she finished checking the answers, she gave more exercises to the students. In going through the answers with the students, she found a few mistakes made by the students and decided to explain the procedures for finding a perimeter again. Then, she moved on to combine the shapes to make composite shapes. Before the lesson ended, Amirah asked a few questions about the perimeter of composite shapes. Most of lesson two was spent on students answering the questions about the perimeter of composite shapes.

Regulatory discourse dominated this lesson (forty-eight percent). The reason for this was because at the beginning of the lesson, Amirah spent almost twenty minutes, going around the class, asking each student questions such as "Have you finish your homework?" At time she scolded students who did not do the homework. This was in great contrast with lesson one where very little regulatory discourse was seen. In the first lesson, the teacher interacted mainly with the whole class while in this follow up lesson she went around to each student to check his or her work. There was also a drop in the use of procedural discourse (from forty-six to twenty-four percent). In this lesson, Amirah seldom went through the procedures for answering the questions. Rather, she let the students write the answers. As for the conceptual discourse, twenty-seven percent of the utterances were made up of this type of discourse. Amirah repeatedly explained the concept of

perimeter whenever the students did not get the correct answer. Another interesting observation of this lesson was the increase in the use of L1 as compared with the previous lesson as shown in Table 5.3.

5.3.2. Aisyah.

Aisyah taught in the same school as Amirah. Her students were also Year Four students and her topic was measurement of length. In a similar way to Amirah, she began her lesson with a quiz on measurement. She read the questions and the students wrote the answers in their books. After that, the students exchanged books and marked the answers. Then, she rewarded the students who did well in the quiz. In this part of the lesson, regulatory discourse was used most often (fifty percent). Sometimes, Aisyah tried to explain the question.

Aisyah: Number 8

Three decade equals to how many years?

Decade is big unit, year is small unit

Big to small you must times

One decade, how many years?

(Transcript 3, stanza 41)

In the above example, Aisyah was explaining the concepts, decade and year, to help her student do the conversion. This was an example of the conceptual discourse used by Aisyah.

Then, she introduced the new topic, measurement of lengths, by showing different rulers and explaining the different uses of these rulers. She also drew students' attention to the units of length.

Aisyah: Okay, now look

(Holding up a ruler)

Standard unit, short measurement

Okay, millimetre

Millimetre is mm

Centimetre is cm

Selalu kita guna bahan seperti short ruler or metre ruler

(*We normally use short ruler or metre ruler*).

(Transcript 3, stanza 44)

In this part of the lesson, the teacher was explaining the unit of measurement and how the length of different things can be measured. The example above illustrated the use of procedural discourse because Aisyah was merely stated the units of length and their abbreviations and did not elaborate. She also used both L1 and L2 in her explanation. After that, she showed the software, which was distributed by Ministry of Education to all primary schools in Malaysia, which explained further about measurement. While doing this, the teacher would stop the computer from time to time and translate what was being said in L1. Then she proceeded with the exercise on how to measure different objects, including a paper

clip, a pencil case, a red pencil, a mouse pad, and a boy. This exercise was done on the computer. One student from each group was called to click on the right answer. While doing this, Aisyah was constantly explaining to her students the steps to calculate the answer.

So, for this part of the lesson, procedural discourse was frequently used (forty-eight percent). An example of this type of discourse used by Aisyah is:

Aisyah: Okay, how many length of the pencil case?

The length of pencil is...

Start from 0, so, it is 6 cm and...

How many? Count...

1, 2, 3...3mm

So, it is 6 cm and 3 mm.

(Transcript 3, stanza 46)

In the example, Aisyah went through the procedure of how to measure the pencil case, using mainly procedural discourse that focused on the steps needed to make accurate measurement, rather than on understanding of the associated mathematical concepts. After that, she divided the class into groups of six and assigned the students the task of recording the measurements of different objects around the class. For this activity, Aisyah used mostly procedural discourse to show the steps in measuring objects but she also used regulatory discourse for class

management. Throughout this part of the lesson, Aisyah used L1 and L2 interchangeably.

Aisyah: Okay, question 2

Breadth of an A4 paper

Maksudnya dia punya lebar

(*Breadth of the paper*)

Question 3

Height of a chair, *nak guna apa*?

(*What are you going to use to measure* the height of a chair?)

Measuring tape or metre ruler?

(Transcript 3, stanza 64)

This example illustrated the point made earlier. Aisyah was reading the questions and translating them into L1. The lesson ended when Aisyah told the students to answer the questions in the textbook as their homework.

In this lesson, procedural discourse seemed to be the most prominent discourse used (forty-eight percent). This type of discourse was mainly used when Aisyah was explaining the procedures involved in measuring the objects, which took up most of the lesson. Regulatory discourse (twenty-two percent) was used mainly in the first part when Aisyah was giving the quiz and also when she was dividing the students into groups. The percentage use of conceptual and contextual

discourses was the same (fifteen percent). These discourse categories were used mainly in explaining the questions.

Aisyah began by asking her students to name the units of length in the next lesson. Then she revised multiplication and decimal topics with students in order to prepare them for the new subtopic, which was conversion of different units of length. Both procedural and conceptual discourse could be observed in this part of the lesson as shown in the example below.

Aisyah: Convert cm to mm

Big to small, you must times 10

Okay, now look

Cm to mm, no decimal

Why no decimal?

Because you must times

Times no decimal

(Transcript 4, stanza 72)

In the example, Aisyah used procedural discourse when she told the students that they have to multiply the number by ten in order to convert centimetres to millimetres. However, when she was explaining why they should multiply and why there was no decimal point in the answer, conceptual discourse was used.

Aisyah: Okay now look centimetre to millimetre, no decimal, no decimal.

Why no decimal? Because you must not time (multiply).

Time no decimal (point).

But from mm to cm, you got one decimal place, One decimal place.

(Transcript 4, stanza 69)

After giving the explanation, Aisyah proceeded with the discussion of answers to some sample questions. Then, she distributed the worksheet and asked her students to answer the questions on the worksheet. When the students had completed the tasks, a few students were called to answer the questions on the board while the other students checked their answers.

In the lesson, more conceptual discourse (thirty-three percent) was used compared with procedural discourse (thirteen percent). The reason for this is probably because Aisyah spent a greater part of her lesson explaining the concepts for conversion of different unit of lengths. The increase in the use of regulatory discourse (fifty percent) could be explained by the fact that in this lesson Aisyah moved around the class more often than in the previous lesson. She used regulatory discourse to control her class.

5.3.3. Amni.

Amni was teaching the topic ‘Mass’ to Year 4 students. For her first lesson, she brought different weighing scales and a few items including onions, eggs and oranges as the resources. She began the lesson by showing the students how to weigh different objects. She started by measuring the eggs, oranges and onions.

Then, she called a student and measured her weight. She used mostly procedural discourse to show how this was done.

Amni: Teacher put some eggs

Please see here

What is the weight?

About 1 kilogram

You write kilogram. The abbreviation is Kg

Okay, say kilogram

(Transcript 5, stanza 118)

In this example, Amni showed her students the procedure to follow when weighing objects. She also introduced the unit for mass, kilogram. This is an example of a procedural discourse because the teacher was merely describing the procedure and did not give further explanation of the concept. The activity was repeated in the same way with a number of items including onions and oranges.

Amni then continued her lesson by showing the software (similar software used by Aisyah, distributed by the Ministry of Education to all schools). A few students were called to answer the questions from the software. Amni constantly stopped the software and explained the tasks. In this part of the lesson, Amni often made the students repeat the answers.

Amni: Okay, the weight of rice

What is the weight of rice?

Amelia

Amelia: 5 Kilogram

Amni: Okay class, say (after me)

The weight of some rice is 5 kg

Students: The weight of some rice is 5 kg

(Transcript 5, stanza 113)

The teacher was asking the students to repeat the correct answer. The verbal interaction here is considered procedural discourse because answers were stated without giving explanations of the underlying mathematical concepts. This lesson ended as the teacher distributed the worksheet to her students.

Procedural discourse was used most frequently in this lesson as illustrated by the examples above. Table 5.3 shows that, forty-eight percent of the lesson was made up of procedural discourse. This was followed by conceptual discourse, twenty-seven percent. Conceptual discourse was used mainly in explaining mathematics concepts, for example, in this situation below, Amni was referring to the pictures from the software.

Amni: Okay look, this is the different scale

Cikgu kata tadi ada macam-macam skala

(*As I've told you earlier, there are different types of scale*)

We use different scale to weight the flour but the mass is still the same.

The mass of the flour is 1kg. The mass of an object do not change even when you change scale.

(Transcript 5, stanza 137)

In this example, Amni was trying to explain to her students that the mass of an object did not change even though they used different weighing scales. Since this utterance involved some kind of explanation for a mathematics concept, the mass, it was included in the conceptual discourse category.

Only seventeen percent of regulatory discourse was used by Amni in this lesson mainly at the beginning of the lesson to introduce the topic and at the end of the lesson, to give the homework.

In the following lesson, Amni continued with conversion of different units of mass. She began with revision of fraction and decimal topics. She emphasised the importance of these topics for the new topic:

Amni: You must remember the fraction and decimal

Because if you want to convert kilogram to gram, gram to kilogram

Okay, must memorise the fraction and decimal

(Transcript 6, stanza 147)

After that, Amni started answering questions on conversion of units of mass with her students. In this part of the lesson, long stretches of procedural discourse was produced as shown by this example.

Amni: You see here, what is this?

Students: Chicken

Amni: What is the mass of the chicken?

Okay, 1 kg and...

Students: 750g

Amni: Okay, the part marking is four,

250g plus 250g equals 500g

500g plus 250g equals 750g

Okay, 1kg and 750g

Convert to kg

One point

Students: Seven five

(Transcript 6, stanza 149)

The example above is a typical example of procedural discourse produced by the teacher throughout the lesson. In this example, procedures were taught explicitly in the sense that the teacher went through all the steps involved until they (teacher and students) got the final answer. In fact, sixty-seven percent of the lesson was made up of procedural discourse (Table 5.3).

After discussing answers to the sample questions, Amni continued to give her students more exercises on conversion. The lesson ended when she finished discussing answers to the given exercises. As stated earlier, the type of discourse

that was most frequently used was procedural discourse (sixty-seven percent). This was followed by regulatory discourse, nineteen percent. Regulatory discourse was used mostly in getting the students' attention. It was also used in giving advice. For example after a lengthy explanation of how to convert to grams, Amni said to her students,

> "I hope you will remember all this. This is how to convert kilogram to gram."
>
> (Transcript 6, stanza 156).

The percentage of utterances classified as conceptual discourse used was twelve percent. This type of discourse was mainly used by Amni to explain the different methods that could be used to convert unit of mass.

Amni: Okay, to convert g to kg

You can do partition

(Pointing to numbers on the board)

Or you can divide

(Pointing to another set of numbers on the board)

You can choose any way you like

Yang mana pun tak apa asalkan dapat jawapan

(*As long as you get the answer*)

(Transcript 6, stanza 161)

In the above example, Amni provided her students with different choices for solving the problem. This was included as conceptual discourse.

5.3.4. Aryana.

Aryana taught younger students, Year Three (nine years old). Aryana in her interview said that her students were difficult to control compared with Amni's class partly because they were younger (Doc. 2a. Class Register). This might explain the frequent occurrences of regulatory discourse, forty-five percent in her first lesson and forty-seven percent in the second.

Aryana's topic was two-dimensional shapes. She introduced her lesson by asking the students to name the shapes she had prepared using cardboard. She showed each shape and asked students to name the shape. This activity involved a lot of repetition and the teacher used a lot of regulatory discourse as shown in the example below. Here, Aryana pointed to and called upon different groups of students to repeat the word "semi circle".

Aryana: Okay class, say semi circle

Students: Semi circle

Aryana: Again

Students: Semi circle

Aryana: Okay, stop, All girls

All girls: Semi circle

Aryana: All boys

All boys: Semi circle

(Transcript 8, stanza 183)

After introducing all the shapes, the teacher asked the students to identify each shape by counting the sides for each shape. In this part, more procedural discourse was observed as shown in this example.

Aryana: Okay, how many sides of heptagon?

Let's count together

Students and Teacher: One, two, three, four, five six, seven

Aryana: Okay, seven

(Transcript 8, stanza 188)

This is procedural discourse because, by counting each side of the shape, the teacher was showing the process of identifying the shape to her students without elaborating on any mathematical concept about the shapes. This activity continued until all the shapes were identified.

After this, Aryana showed the students how to draw these two-dimensional shapes. Again, more procedural discourse was observed here as Aryana went through the steps in drawing each shape. Before the end of the lesson, students practiced naming the shapes through the exercise provided in the software. As

stated earlier, Aryana used a lot of regulatory discourse, forty-five percent, in this lesson. This discourse was used in controlling the class, for example, calling for attention, and giving instructions. However, procedural discourse was used the most by Aryana fifty-two percent. Procedural discourse was used in the process of identifying the shapes and drawing the shapes as illustrated in the above example. Very little conceptual discourses was observed (three percent). The only occurrence of conceptual discourse was when Aryana read the definition from the textbook and explained the meaning to the students. Aryana used mostly English in her lesson with some Bahasa Malaysia for regulating students' behaviour, for example, *dengar sini* (*listen*).

In the second lesson, Aryana began by asking the students to identify the shapes of different objects in the classroom including the table, the blackboard, and the book. After that, she continued with naming the shapes in the textbook. This exercise was carried out in a similar way to that in the previous lesson whereby the teacher would point to each shape and call upon groups of students to name it.

Aryana: Okay, look at diagram one

I show the diagram, you say the name

Diagram one

Students: Semi circle

Aryana: Girls

Girls: Semi circle

Aryana: Boys

Boys: Semi circle

(Transcript 8, stanza 183)

This type of interaction went on until Aryana had covered all the shapes. Similar to the previous lesson, this activity involved using regulatory discourse because the teacher was only calling the names of the group and she did not utter any mathematics terms.

After that, Aryana proceeded by giving tips to the students on how to remember the names of the shapes. Interestingly enough, in this part of the lesson, Aryana had switched to using L1 for her explanation.

Aryana: Octagon, octagon

August, August is the eight month

Jadi, Ogos, eight, lapan, octagon

(*So, August, eight, octagon*)

(Transcript 9, stanza 208)

As discussed in the section 4.2.4, this type of utterance was included in contextual discourse because the teacher drew upon everyday familiar concepts to

help students understand a mathematics concept. In the example above, the teacher used the name of the month, August, to help her students remember that an octagon has eight sides.

The lesson continued with more exercises from the textbook. This time the students had to match the name of the shapes to the diagrams. Aryana called a few students to answer. She also checked the answers with the whole class.

Like previous lesson, the occurrence of regulatory language was high in this lesson (forty-seven percent). This type of discourse was used mainly to control the class. The students were constantly making noise especially when the teacher asked individual students to answer. The teacher had to stop the lesson a few times to control the class. The use of procedural discourse had decreased slightly from the previous lesson because in many instances, the teacher only gave answers or asked students to give answers. Thirty-one percent of the utterances were classified as procedural discourse during this lesson. Contextual discourse was observed mostly when Aryana was giving her students tips on how to remember the names of the shapes and the number of sides they have.

5.3.5. Comparison among the teachers.

The participants for this research were mathematics teachers from two different schools in Malaysia. There are a number of similarities among them despite the location of the schools. First, the teachers seemed to follow a similar structure for each lesson. As a result, a similar pattern of discourse was observed in all their lessons.

In the first part of the lessons, all teachers used regulatory discourse to get the students to settle, ready for the lesson. This was followed by some introduction of the topics. Contextual discourse and conceptual discourse were used more than other types of discourse in this phase. The rest of the lesson involved some kind of practice; students would answer questions, and teachers would check answers. The similarities in lesson structures and resources used may be attributed to the fact that all the teachers referred to similar curriculum and syllabus. As mentioned earlier in Section 3.1, the education situation in Malaysia is a prescriptive one with common syllabus and curriculum specifications used in setting lesson objectives. The resources such as the textbooks and the software provided to the schools are also the same throughout the nation. There is also probably very little difference in the type of test questions prepared by these teachers because, tests tend to follow similar formats, reflecting the format of the major examinations all students face at the end of the year.

However, each teacher had a different teaching style which resulted in slightly different percentage in discourse usage by each as seen in Table 5.3.

The first part of the chapter described the findings according to four types of discourse categories. In the next part, the type of discourse which may be helpful for students who are learning mathematics in their second language is focused on.

5.4. Language Related Strategies.

As discussed in Chapter Two, researchers in the field of teaching mathematics in a second language agreed that teachers' discourse practice has some impact on the learners'

acquisition of mathematics language (Khisty & Chval, 2002; Meaney, 2006; Setati & Adler, 2000; White, 2003). In this section, the language related strategies that were used by the teachers are discussed. Meaney's (2006) Mathematics Register Acquisition Model is used as the frame for presentation.

Meaney (2006) suggested that students acquire mathematics register in a manner similar to the way they acquire a second language. She developed a model of Mathematics Register Acquisition (MRA), which was discussed earlier in Chapter Two. In this section the teachers' use of language-related strategies will be discussed using the stages in the MRA model: noticing, intake, integration, and output. In developing the MRA model further, Meaney et al. (2007) identified two main strategies, modelling and scaffolding, used by teachers in assisting students to acquire mathematics terms. They then came up with different strategies within these two main strategies. All these strategies will be discussed with reference to the data collected from the participants of this study.

5.4.1. Noticing.

In this first stage, students are introduced to new terms or expressions. At this stage, the teacher plays an important role in highlighting the terms and their usage in a mathematics context. Among typical teaching strategies used are repeating new terms several times at appropriate places, rephrasing, and giving a definition verbally and through the use of diagrams. Repetition was the most common strategy used by all the teachers in the current study.

In introducing the different shapes, Aryana repeated the word, 'semi circle' five times in different places throughout her lesson (Transcript 8). She made her

students repeat the word twelve times (Transcript 8). Amni, on the other hand made her students repeat the sentences or the final answers that she got after solving mathematics problems as in this example:

Amni: What is the mass of a chicken?

Okay, please say after teacher

Just follow me okay

The mass of a chicken is 1 kg and 750g

(Transcript 5, stanza 141)

Apart from the use of repetition, the teachers also gave definitions of new terms verbally or through the use of diagrams. Quite often the teachers in this study resorted to use of L1 when explaining new terms or expressions. For example, in explaining the term, *isosceles triangle*, Amirah said this:

Amirah: Isosceles triangle is like your legs

Okay, the real diagram is like this

(Drawing the diagram on the board)

This is the triangle

Segitiga sama kaki

(*Isosceles triangle*)

(Transcript 2, stanza 32)

Another strategy was when the teachers called for students' attention before introducing the new term. This was done by all the teachers by saying, look here or look to the front. These expressions were normally used in English unless students ignored the instructions.

In this stage teachers employed various strategies to focus students attention to the new terms used. Meaney et al. (2007) suggested that in order for the strategy to be effective, it must contribute to students hearing the vocabulary often enough and understanding the meaning. The strategy that was commonly used by the teachers who participated in this study was repetition. In explaining a new term, the teachers would sometimes use L1.The use of L1 as part of the teaching resource is supported by a number of researchers. (Khisty, 2000; Moschkovich, 2002; Setati & Adler, 2000). There were also teachers who had prepared a diagram or drew one to help with the explanation. Last but not least, regulatory discourse which called for students' attention was also a useful strategy to emphasise the importance of what the teacher was going to tell them.

5.4.2. Intake.

At this stage of the MRA, students are expected to be able to give definitions for the terms they have learnt. The teacher's role is to check the students' understanding. The strategies listed by Meaney et al. (2007) for this stage include choral responses with students, giving the first syllable of a term and have students completed it, asking students for a definition, and focusing students back

on the main idea being discussed to help solve the problem. All the teachers who participated in this study used one or two of these strategies. For example, in the excerpt below, Amirah recalled the definition of perimeter with her students in order to answer the question:

Amirah: Okay, I have this shape here

How do we find the perimeter of this composite shape?

I already write the length of each side

But remember that perimeter you must find what?

Students: Outside

Amirah: Yes, the length outside the shape, *luar sahaja* (*outside only*)

(Transcript 1, stanza 18)

In this example, Amirah prompted her students to get the correct answer. At this stage, Meaney et al. (2007) suggested that effective strategies are the ones that support students' understanding through exploration of how and when to use the new terms. Aisyah provided choices for her students to elicit the correct answer from them.

Aisyah: So, for the length of a pencil, which unit should you use?

mm? cm? or m?

Student: cm.

(Transcript 3, stanza 49)

In this example, Aisyah was making sure her students understood the different units of length.

Aryana encouraged the use of correct terms by asking the student to repeat the answer and praising the student when the answer given was correct.

Aryana : Yes, Zaris

Zaris : Qualilateral

Aryana: Again

Zaris : Qualilateral

Aryana: Good

(Transcript 9, stanza 213)

At this stage, the teachers' role was to encourage the use of new mathematics terms by students. In this study, the teachers did this by prompting for the correct term, asking students to choose the correct term and asking the student to repeat the correct usage so that other students would also be able to listen to it.

5.4.3. Integration.

At this stage of the MRA, the teacher slowly withdraws the scaffolding provided so that students can use the new register on their own. However, at times the teacher might have to step in to ensure accuracy. This normally involved doing exercises together with the students. Teachers have the chance to check the understanding and remind the students of what they already know.

Amni, for example, encouraged her students to draw upon the previous knowledge in doing conversion of units of mass:

Amni: Okay, 3 kg and 500g, convert to g

3 kg?

Students: 3000g

Amni: How do you get that?

Students: because 1 kg 1000g

Amni: Okay, 3 kg convert to smallest unit

You must...

Students: Multiply

Amni: 500g?

Students: 3000g plus 500 g equals 3500g

(Transcript 7, stanza 172)

In this example Amni was constantly asking questions to encourage the children to reflect upon what they already know to solve the problem.

5.4.4. Output.

At this final stage of MRA, students are expected to show their fluency in using the mathematics register. The teacher's only role is to provide the opportunity or the environment for the students to do so. In the case of this study, the teachers normally would give further exercises for the students to do. Since this research did not have focus on the students, no certainty about the students' usage of mathematics register can be inferred. The only indication of their acquisition of specific terms like *perimeter* was their ability to find the perimeter of any shapes. It was observed that some students successfully answered the questions on the board.

In this section the use of language-related strategies used by the teachers in this study has been discussed. The study provided more evidence to support the strategies teachers used at the noticing stage compared with the later stages. It may have been that, because at the later stages, especially at output stage, the teachers

had already withdrawn the support as they saw the students becoming more fluent in the mathematics language they had acquired. In the case of this research, there was little evidence gathered about this fluency as students rarely gave extended answers. However, the teachers were observed to be using similar strategies like repetition and prompting. All the teachers also fell back on L1 especially in explaining the more complex mathematics concepts.

5.5. Conclusion.

In this chapter, the data from the studies on teaching of mathematics in a second language in Malaysian primary schools was presented. The discourse categories that emerged from the data; namely procedural, conceptual, regulatory and contextual discourses were described. The patterns of their occurrences were summarised in Table 5.2 and 5.3. Extracts from each teacher's lessons were presented and the use of these different discourse categories and reasons for their use were highlighted. In the second part of this chapter, the use of language related strategies by the teachers was examined using Meaney's (2006) MRA model as the guideline for the discussion. In the next chapter, the presentation of data particularly dealing with language issues including code switching and errors in using L2 will be presented.

CHAPTER SIX

LANGUAGE ISSUES

6.0. Introduction.

It was established earlier in Chapter Two that language plays an important part in teaching and learning mathematics. Researchers like Moschkovich (2002), Khirsty (2000) and Setati and Adler (2000) have demonstrated the complexity of having to teach or learn mathematics in a second language. In multilingual classrooms, teachers face the challenges of having to teach their subject matter in a language that students are currently learning. While the primary aim of this research was to examine mathematics teachers' classroom discourse, the data collected have also raised several issues related to language. First, the use of L1 by the teachers, in this case is the use of Bahasa Malaysia in teaching, and second, the presence of errors made by teachers in using their L2, English, to teach mathematics. In the first part of this chapter, the use of L1 in an L2 learning environment with particular reference to the code switching practice among the teachers is discussed. The second part of this chapter focuses on errors made by teachers in using the second language (L2). Data for this chapter are taken from classroom observations and findings confirmed through interviews during the stimulated recall sessions.

6.1. Use of the First Language (L1).

There has been an ongoing debate over the use of first language in the teaching of a second language. While it is believed that the use of L1 by teachers would hinder learners' progress in L2, many researchers (Kasule & Mapolelo, 2004; Mochkovich, 2002; Setati & Adler, 2000) advocate the use of L1 or code switching in the teaching of mathematics. Kasule and Mapolelo (2004) in their research of strategies used by mathematics teachers teaching in primary schools, listed code switching as one of the strategies. Mochkovich (2002) stated that code switching is a support that teachers could offer to learners who are still developing their proficiency in L2. Setati and Adler (2000), in their research of mathematics teachers in South Africa, stated that code switching should be seen as a particular phenomenon unique to multilingual contexts.

Code switching was also a common phenomenon observed in the data collected for this study. The teachers used L1 in a number of instances for a number of reasons, which were pointed out by the teachers in this study during the interviews. The use of L1 by teachers is now presented according to the themes or functions of L1 in their utterances.

6.1.1. Use of L1 for explanation.

All the teachers in this study used L1 in their lessons. One of the main functions of the use of L1 was for explanation or clarification of concepts. Amirah used L1 to explain to her students about the concept of perimeter.

Amirah : Okay, how to find perimeter?

Make sure you know the meaning of perimeter

Keseluruhan

(*The total*)

This is very important

Luar sahaja,ukur lilit perimeter

(*The outside, measure outside only*)

(Transcript 1, stanza 18)

When asked about why L1 was used, Amirah said,

> Well, (I) use Bahasa Malaysia because the students need to understand the meaning of perimeter. If not, they might not know how to calculate when it gets complicated. So, I thought I can translate in Bahasa Malaysia because this is important.
>
> (Stimulated Recall1, line 4)

In the next example, Aisyah used L1 to explain about the decimal point. Here, she was showing her students the steps to follow in converting the unit mm to cm.

Aisyah: Convert mm to cm

You got 1 decimal point

Awak akan dapat satu tempat perpuluhan sebab 1 cm bersamaan dengan 10mm

(*You have 1 decimal point because 1 cm equals to 10 mm*)

(Transcript 4, stanza 69).

Similar to Amirah, Aisyah also felt that it was important that the students understood this procedure so that they could answer similar questions they might come across later. She said:

This is an important part. Students need to understand. If I use Bahasa Malaysia I am sure everybody understands.

(Stimulated Recall 3, line 2)

In another example, Amni used L1 to show her students the way to get the correct reading from a weighing scale.

Amni: Okay, when you see

(Pointed to the weighing scale)

You see your eye is *tepat*

(*You must look from the correct angle, like this*)

Tak boleh tengok kot ni

(*You cannot look from the side*)

(Transcript 5, stanza 124).

Amni was demonstrating to her students the right way of reading the weighing scale. She used L1 to accompany her action. During her interview, she also gave a similar reason to that provided by other teachers, but admitted that she did not know the correct English word to use.

I wanted the students to understand this important part. I used Bahasa (Malaysia). I didn't know how to say that in English. Students may become more confused.

(Stimulated Recall1 5, Line 3).

In fact, using L1 for explanation is a common occurrence in teaching mathematics in second language. Setati and Adler (2000) recorded similar findings in their research on the use of code switching by mathematics teachers in South

Africa. They found that code switching was often used in explanation of concepts and the teacher would switch to using L2 when she was demonstrating calculation with her students.

Sometimes code switching was needed because students did not understand what the teacher was saying. Aryana, for example, began her lesson by asking the students how they were.

Aryana: How are you today?

Students: Tuesday

Aryana: How are you today?

Cikgu tanya kamu macamana, sihat ke tidak?

(I am asking whether you are okay or not?)

(Transcript 8, stanza 181)

Aryana explained this in her interview:

> You know, I have to translate here. They do not understand what I was saying. They do not answer my question. Actually, this is a D class. So, you know, they are not good student.
>
> (Stimulated Recall 7, Line 3).

In Malaysia, students are put in classes according to their performance during the final year examination. Aryana felt that she had to translate because her students were weak in English being in the D class, which is the second last class for Year Three in the school. She further elaborated about her class:

I know, I am not supposed to use Bahasa Malaysia. But when I see they (the students) look blank, I translate because they cannot learn this way.

(Stimulated Recall 8, Line 2).

This situation was not present in any other teachers' lesson. The reason for this was may have been because all the other teachers were teaching slightly older students. Kasule and Mapolelo (2004) suggested using code switching as a teaching strategy especially with younger students who are not proficient in the second language. Setati, Adler and Bapoo (2002) explained that in a rural area, teachers are expected to use more of L1 because the students are less proficient. A teacher in Tan and Ong's (2008) study also mentioned that he had to assume the role of a translator because of the students' lack of proficiency. This example clearly illustrates the point made by the researchers. They also raised the issue of a teacher feeling uncomfortable about using L1 because they know that their students rely on them for L2 input. Aryana, like the teachers mentioned by Setati et al. (2002), knew that code switching should not happen, but she felt she had no alternative.

6.1.2. Use of L1 for regulating behaviour.

Another function of using L1 is for classroom management. In the instances that follow, teachers used L1 to give instructions, asking individual students to perform a task or for reprimanding mischievous students. A common example of the use of L1 for this function is when a teacher is giving instructions to the students.

In this example, Aisyah was getting her students to stop working and pay attention to what she was going to say.

Aisyah: Stop your work and look at the worksheet.

Berhenti sekejap,tengok saya punya worksheet, okay?

(Stop for a while and look at the worksheet okay?)

Lepas ni awak boleh sambung.

(After this you can continue with your work)

(Transcript 4, stanza 76).

Here Aisyah used L1 to give instructions. She was merely translating the instructions that she had already given in English. When asked why she translated the instruction, she said:

I thought I'll make it clearer and that certainly got their attention. They all looked up when I say things in Bahasa Malaysia

(Stimulated Recall 3, Line 2).

Aisyah thought that her students paid more attention to her if she spoke in Bahasa Malaysia. Another example came from Amni when she was showing the different weighing scale to her students. She called a student to the front of the class and told the student to step on the bathroom scale.

Amni: This is the scale to measure your weight.

The unit is in kg

Okay, naik atas penimbang

(*Okay, step on the scale*)

Kamu punya berat, 35kg

(*Your weight is 35kg*)

Her weight is 35kg.

(Transcript 5, stanza 117)

When she used L1, Amni was actually addressing the student who was in front of the class. She commented in the interview that she was only giving the instruction to the individual student and did not think the others might hear her.

I was telling Husna (the student). The others did not hear.

(Stimulated Recall 6, Line 1).

In the next example, Aryana used L1 to get her students attention.

Aryana : *Dengar sini cikgu nak cakap. Letak buku teks.*

(*Listen to what I am going to say. Put down your books*)

(Transcript 9, stanza 206)

According to Aryana, L1 was used to make sure the students were paying attention. Sometimes you have to give instruction in the language that they all understand.

(Stimulated Recall 7, Line 2).

Another example where one of the teachers used L1 for classroom management was when Amirah scolded her students for not doing their homework.

Amirah: Ha, homework *tak buat,macamana nak pandai? Kenapa tak buat?*

(*Why don't you do your homework? How do you expect to be good at this?)*

(Transcript 2, stanza 26)

Amirah gave a similar explanation to that given by Aryana. She felt it was necessary for her to scold the students in Bahasa Malaysia so that they knew their behaviour was unacceptable. She also brought up an interesting point in her response:

> There is no point scolding the students in English because they might not understand. I want them to know that I am not pleased with their behaviour. After all, this is not part of the lesson. So, I think I can use Bahasa Malaysia.
> (Stimulated Recall1, Line 8).

Amirah justified her use of L1 by stating that this was not an important part of her lesson. In fact she did not think that it was part of her lesson. The use of L1 was also prevalent when teachers were addressing individual students. Sometimes, the teachers asked a few students to do exercises on the board and these students would ask for clarification from the teachers. The teachers normally answered in L1.

Another example is when Amni gave a written exercise to her students. As the students were answering the questions, she went around the class and asked individual students if they had problems.

Amni: Faiz, have you finished?

Faiz : Betul tak, cikgu? (Is this correct,teacher?)

Amni: Awak kena pecahkan. (You have to separate the answer)

(Transcript 6, stanza 148)

Amni talked about this in her interview,

I guess I automatically answer in Bahasa Malaysia because he asked (in the language).

(Stimulated Recall 6, Line 6).

In a similar way, in this example when Aryana called a few students to answer the questions from the software, she viewed the communication as being on a one-to-one basis. She explained the task to her student (Zaris) in L1.

Aryana: I will call one member from each group

First, Zaris, come to the front

Tengok rajah dia,gambar dia,tengok kat sini

Picit yang mana? Nama dia

(Look at the diagram here and click on the name)

(Transcript 9, stanza 217).

In the stimulated recall session, Aryana said that she used L1 for better communication with her student. Like her colleague, Amni, she did not think that other students could hear the conversation:

I talked in Bahasa Malaysia to the student for better communication. He can answer fast. Besides, the others did not listen to it.

(Stimulated Recall 8, Line 6).

Setati and Adler (2000) observed similar situations when teachers would switch to L1 in an informal interaction with individuals or small groups. However, there was an example which showed the opposite situation. Amirah asked a few students to answer the questions on the board. One of the students had a problem and asked her for help.

Lam: Macamana cikgu?

(Teacher, how to answer this question?)

Amirah: You must know each side

There are 4 same sides, isn't it?

So, find the total of the sides.

(Transcript 1, stanza 12)

In this interaction between Amirah and Lam (the student), Amirah used English to answer Lam's question which was in L1. Her choice of language was opposite to observations in the previous two examples. The only difference in this situation from the previous ones was that the student, Lam did not share the same L1 with Amirah. However, Lam could understand Bahasa Malaysia. In the interview, Amirah said that she used English, despite being asked in Bahasa Malaysia, because everyone could hear her explanation:

> Well actually there was no specific reason for using English. I did it for the benefit of everyone. Everybody can listen to the explanation. (Stimulated Recall 2, Line 4).

The question was asked in L1 and was, seemingly prompting an informal interaction, yet Amirah made a quick decision, to respond in L2.

6.1.3. Habit.

There were also many instances when the teachers could not explain why L1 was used because they were not even conscious that they had spoke in Bahasa Malaysia. Most of the time, the utterances were limited to one or two words like '*Faham tak?*' (*Understand?*), '*Berapa?*' (*How many?*) and '*Betul tak?*' (*Is it*

correct?). These utterances have two common characteristics. First, they were non-mathematics language. Second, they were questions and they were normally used to check students' understanding. Often, the teachers could not provide an answer as to why they used Bahasa Malaysia in these sentences:

One teacher just answered, "I didn't realise that"

(Stimulated Recall 7, Line 5).

In this section, the different purposes for using L1 were discussed. In the next section, the use of L1and L2 by each teacher will be presented.

6.2. Summary of the Use of L1.

In this next section, the use of L1 and L2 by individual teachers is summarised with the help of the table below. Table 6.4 presents a summary of the percentage of L1 and L2 utterances used by each teacher across each of their two lessons.

Table 6.4:

The Usage of L1 and L2 in the teachers' Classroom Discourse.

Teachers/lessons	Use of L1 (%)	Use of L2 (%)
Amirah /Lesson 1	6.0	94.0
Lesson 2	12.6	87.4
Aisyah Lesson 1	26.3	73.7
Lesson 2	5.7	94.3
Amni Lesson 1	7.0	93.0
Lesson 2	2.4	97.6
Aryana Lesson 1	3.3	96.7
Lesson 2	14.6	85.4

The first teacher, Amirah was teaching a unit on perimeter. In her introductory lesson, Amirah used mostly L2 (ninety-four percent). However, more L1 was used in the following lesson. It has been observed that she used L1 mainly for regulatory purposes, like giving instructions. An example of Amirah's use of L1 to give instruction is:

Amirah: *Okay, tutup buku*.

(*Close your book*).

(Transcript 1, stanza 1)

She also used L1 to explain the concept of perimeter such as in the first example, which was given earlier in Section 5.3.1. During her interview, Amirah seemed to be able to justify her use of L1 for most of the time. She maintained that she only used L1 when the need arose:

> I tried to speak in English as required by the Ministry of Education. Sometimes, I speak Bahasa (Malaysia) because I want my students to really understand the topic. They need to understand to do the exercises. I used Bahasa Malaysia for the parts (that is) not important, not mathematics.
>
> (Stimulated Recall1, Line 12).

Compared with other teachers, Aisyah, on the other hand, used L1 most (twenty-six percent). Similar to Amirah, Aisyah also used L1 for regulatory discourse. For example, this excerpt was taken when she wanted to introduce a new lesson.

Aisyah: *Okay, hari ini kita akan belajar macamana cara mengukur menggunakan unit m*
dan mm, cm dan mm, m dan cm,
Okay,boleh faham?

(*Today we are going to learn measurement of length of objects using the unit m and mm, cm and mm, m and cm, okay.*

Can you understand?)

(Transcript 3, stanza 42).

Aisyah also used L1 for procedural discourse. For example, in showing her students how to measure a paper clip, she also used L1.

Aisyah: You must start from zero mark to twelve mark.

Awak kena kira dari nombor kosong atau pun sifar sampailah yang terakhir, nombor duabelas.

Awak tak boleh kira daripada number one to twelve.

(You cannot count from...)

(Transcript 3, stanza 45)

In this example, Aisyah used L1 to elaborate what she had already said in English. Another interesting observation about Aisyah in the above example was her use of code switching, in which she switches between languages in the same sentence. Another example of code switching occurrence in Aisyah's lesson;

Aisyah: How many length of *pencil merah?*

(*What is the length of the red pencil?)*

(Transcript 3, stanza 90).

The addition of a L1 word here was actually not needed as it did not bring any additional meaning to the question. In most cases, Aisyah merely provided the direct translation of what was already said. While in some instances it was necessary to do so, in other instances it was redundant. For instance, when doing the exercise using the

software provided by the Ministry of Education, Aisyah would also provide the translation of the question.

Recording (software): What is the height of this boy?

(A picture of the boy and the measurement was shown on the screen)

Aisyah : *Maksudnya ketinggian untuk pelajar ni*

(*Meaning the height of this boy*)

(Transcript 3, stanza 51).

When she was asked to comment on her use of L1, she said:

> Most of the time I think it (is) important to translate. Students do not understand. They (looked) blank. My lesson cannot proceed like this. (Stimulated Recall 4, Line 10).

Aisyah was not confident that her students would understand if English was used in teaching. In her second lesson, the use of L1 was significantly reduced, from twenty-six percent to six percent (see Table 6. 4). Since this lesson did not differ much from the previous one, there seemed to be no specific reason for this reduction. Perhaps Aisyah had become more conscious of her use of L1 because this lesson was recorded after the first simulated recall session was conducted.

Amni is the teacher who used L1 the least. She tried to use English as much as possible and felt confident in giving instructions in English. When she could not explain a certain idea, she would either use the real objects, including bringing the different weighing scales to class, or she would draw a diagram. In all instances, Amni used L1 to explain concepts.

Amni: Okay, this is the whole number

This is fraction number

Pecahan nombor bulat

(Transcript 6, stanza 149).

Amni commented that:

> I used Bahasa (Malaysia) here to remind students of what they have learnt earlier.
>
> (Stimulated Recall 5, Line 8).

Like Amirah, Amni also felt that she only used L1 whenever it was really needed. Aryana used L1 mostly to regulate her students' behaviour. In her first lesson she only uttered one sentence in L1, which was an instruction for students to do the exercise in the book. In her second lesson, more L1 was used by Aryana but the use was still limited to regulatory purposes only. An example of this was when she wanted her students to pay attention to her explanation.

Aryana: Okay, class listen

Dengar sini cikgu nak cakap,letak buku teks

(*Listen to me, put down your textbooks*)

(Transcript 9, stanza 206).

Aryana made a few interesting comments regarding her use of L1:

> It was very difficult for me. My students are weak in English. They will not listen because they do not understand.
>
> (Stimulated Recall 8, Line14).

> I know I must use English because students are going to answer the exam in English. But I have no choice. I don't think my students are ready to learn in English.
>
> (Stimulated Recall 8, Line 16).

This section summarises the frequency of L1 usage by each teacher. There are a number of conclusions that can be made from these findings. First, teachers' use of L1 varied from one lesson to another. For example, only 6 percent of Amirah's first lesson was in L1, but the percentage increased to twelve percent in the second lesson. Amirah used L2 most in presenting information in her introductory lesson. However, in the second lesson where students began to do mathematical exercises, Amirah used more L1 especially when addressing smaller groups. This observation supported the claim made by Lin (1996) that code switching occurs according to contexts. In fact, the contexts for code switching found in this research were similar to those found by Lin in her study. Teachers normally used L1 in an informal situation, especially when addressing individual students or small groups. Second, some teachers used more L1 than other teachers. Aisyah used L1 the most: twenty-six percent of her lesson was in L1. Amni, on the other hand, used only two percent of L1 in her second lesson. A few researchers including Sam et al (2009) and Tan and Ong (2008) suggested that younger (less experienced) teachers were less confident in using English in their teaching. This may also account for Aisyah's language usage as she was the youngest teacher observed in this study.

In general, a few patterns could be observed from the teachers' use of L1. Teachers used L1 mainly in regulatory discourse. This was to ensure that students

followed the instructions. Another reason as stated by Amirah, was that teachers did not consider these instructions as mathematics language. Teachers seldom used L1 for procedural discourse. Besides, L1 was used in interactions with individuals or small groups, while English was used mainly in whole class interactions. The teachers in the rural schools, Amni and Aryana used L1 less often than the teachers in the urban schools. As stated in the discussion on English in Malaysia, in Chapter Three, students in rural schools in Malaysia tend to be less proficient in English because of limited exposure to the language. It was surprising to see that these teachers use more English than those in the urban school. Furthermore, the students were all Malays and they shared the same L1 as the teachers. One explanation offered by Setati and Adler (2000) for this was that the teachers felt it was their responsibility to induct their students into mathematics English and so made more of a conscious effort to use L2 more often. In this study, while the teachers used L1 mainly in scolding the students, encouragement or praise was given in English. This is opposite to the findings made by Khisty (2000) and Setati (2005), where teachers used L1 for encouragement, or as a mark of solidarity.

6.3. Language Errors.

Another language issue that has emerged from this study concerns the errors made by the teachers in teaching mathematics in a second language. In the literature, there has been discussion on the impact of teachers' discourse practice on students' learning. So far, researchers have pointed out that the use of certain types of discourse, for example conceptual discourse, may benefit the learning process. However, the assumption is that the teachers are fluent in the teaching language. This may not be the case as the teachers

in this study were also second language speakers. Learning a second language is a difficult task; teaching in a second language could be even more difficult.

The teachers in this study were all second language speakers of English. All of them spoke Bahasa Malaysia as their first language. While they had learnt English in schools, none of them was trained to teach in English, except through the ETeMS course they had attended. This section on language errors is not intended to point out the teachers' weaknesses. It is hoped that through this discussion, more research will be done in this area so that suitable training programmes will be set up to cater for the needs of the teachers.

For the purpose of discussion, the errors which occurred during the classroom observation have been divided into categories, ranging from minor errors to major errors. Wherever possible, the students' reactions to the error are described to give an indication of the immediate effect on them, as observed.

6.3.1. Minor errors.

In this discussion, an error was considered as a minor error if it did not change the meaning of words. This category may include the omission of a verb (e.g. "is") or a determiner (e.g. "the"). It may also include wrong use of tenses or wrong word order.

As Amirah was discussing the lengths of different sides of a triangle, she pointed out to the students that two of the same sides have the same length.

Amirah: Example here I use this ruler and I get a 15 centimetres.

How about this?

(Pointing to the other side)

Also same

(Transcript 1, stanza 8).

In this example, Amirah made a few minor mistakes. First, she omitted the word “for” before the word “example”. Second, she added a determiner, “a”, before “15 centimetres”. Lastly, she used an awkward expression “also same” in indicating that both sides were the same.

Aisyah was measuring the length of a pencil case with her students.

Aisyah: How many length pencil case?

Students: 6 centimetres.

(Transcript 3, stanza 46).

Here, Aisyah was asking her students the length of the pencil case, and the use of the word “many” was inappropriate. However, she still got the correct answer from her students.

In this example, Amni was looking at the picture of a cucumber on a scale. She was asking the whole class to read the number on the scale. After they had given the correct reading, Amni wanted to repeat the answer.

Amni: The answer is 2.5 kg

Okay, teacher forward

2kg + 500g

2.5kg

(Transcript 6, stanza 151).

Amni was explaining to the student how they got the answer. She used the word “forward” when she really wanted to say “repeat”.

In the next example, Aryana was showing the students how they could remember the name of the shape “pentagon” and the number of sides it has.

Aryana: Pentagon, how many sides?

Students: Five

Aryana: How you want to remind?

(Transcript 9, stanza 209)

Here, the mistakes that Aryana made were the omission of the word “do” before the word “you” and the wrong choice of word “remind” when she wanted to say “remember”.

The four examples given above illustrate some of the minor errors made by the teachers. These errors occurred mainly because of direct translation from the first language to the second language. The occurrence of these errors did not seem to affect the students’ understanding of the content. While grammatically these sentences were incorrect, they did not hinder students’ learning of mathematics. In the next part, errors in pronunciations will be discussed.

6.3.2. Errors in pronunciation.

There were a few errors in pronunciation observed during this study. One example was when Aryana asked the students to repeat the word “semicircle”. However, she pronounced it wrongly and as a result, all the students also pronounced the word incorrectly. There were also instances when the teachers’ mistakes in pronunciation changed the meaning of the words. These errors may be considered major errors.

Aisyah pronounced the word “measurement” as “management”.

Aisyah: Standard unit

Short *management* is?

Students: Ermm

Aisyah: Now, long *management* is?

Students: Ermm

(Transcript 3, stanza 44)

In this example, Aisyah pronounced the word “measurement” as “management” twice. However, in both instances, she eventually managed to get the correct answer from the students.

Amni pronounced the word “flour” as “floor”.

Amni: Faiz, what is the mass of the *floor*?

Stand up

Faiz: 2kg and 500g

(Transcript 6, stanza 148)

Amni said “floor” while she was putting the flour on the weighing scale. Despite the wrong pronunciation, she still got the answer she wanted from her student, probably because he could see the flour on the scale and guess what the teacher meant.

While the errors changed the meaning of the words entirely, these errors were not put into major error category because it seemed that the students still understood the intended meaning and gave the correct answers. The use of non-verbal language such as using the real object (flour) helped the students to

understand what the teacher was meaning although she made the pronunciation mistakes.

6.3.3. Errors in vocabulary.

Sometimes, the teachers made mistakes in their word choice and used words that carried a different meanings altogether.

Amni was showing her students how to weigh the shallots that she had brought to class.

Amni: Okay, what is this?

Onions

(Transcript 5, stanza 123).

Amni used the word onions when she was actually holding the shallot. This mistake, however, was a minor one because it was not a mathematics term and did not affect the calculation that they made later. Furthermore, none of the students seemed to notice the mistake.

Similarly, in these examples, three of the teachers had used the word "tomorrow" when they meant to say "yesterday".

Aisyah: Okay, close your books

Now, tomorrow

Semalam kita belajar apa?

(What did we learnt yesterday?)

(Transcript 3, stanza 43).

Aisyah had used the word "tomorrow" when she was referring to what they had learnt the day before. However, she corrected her mistake in Bahasa Malaysia.

Amni: Okay, (in) tomorrow lesson, we learnt about the mass of object

(Transcript 6, stanza 147).

Similarly, Amni said “tomorrow’s lesson” when she actually meant “yesterday’s lesson”. She did not notice her mistake and just carried on with the lesson.

Aryana: Class, refer to what we learnt tomorrow eh, yesterday.

(Transcript 8, stanza 182).

Aryana also made the same mistake but was quick to correct it. It was interesting to note that three teachers who were from different schools made the same mistake about the use of ‘tomorrow” and ‘yesterday”. However, this mistake could be considered as a minor mistake since it did not involve mathematics terms, nor did it affect the learning activity that followed.

6.3.4. Major errors.

In this study, two major errors were observed. They were categorised as major errors because they affected the students’ understanding and the activities that were carried out later on.

In this example, Aisyah was explaining the questions from the computer software to her students.

Aisyah : Okay, measuring thickness of a mouse pad

Maksudnya ketebalan tetikus awak.

(Meaning the thickness of your mouse)

Tetikus tu panjang ke pendek?

(Is the mouse long or short?)

Students: Pendek

(Short)

Aisyah: *Pembaris mana kita nak guna?*

(Which ruler should we use?)

Students: *Pembaris pendek*

(Short ruler)

(Transcript 3, stanza 50).

Aisyah had wrongly translated a mouse pad as a mouse. Students interpreted the question as asking them to find the thickness of a mouse instead of a mouse pad. However, they were right when they said they could use a short ruler to measure it because both objects could be measured using a short ruler. The actual measurement of both objects would be different and the students would write the wrong answer because of this misunderstanding.

In the next example, Amni was explaining to her students how to convert the unit gram to kilogram.

Amni: So, number two

What number is this?

Students: 7050g

Amni: 7050g

Okay, convert to kg

(You must) multiply or divide?

Students: Divide

Amni: Multiply

The smallest unit to biggest unit

You can multiply, multiply what number?

Students

Amni: 1000

Answer is 7.05 kg

(Transcript 7, stanza 166)

The mistake that Amni made in this example was using the word “multiply” when she actually meant “divide”. The students’ answer was correct. She managed to get the correct answer because she was actually doing the division on the board, but all the while she was referring to the procedure as multiplication. The students were confused after their teacher said their answer was wrong, when in fact it was right. Therefore, none of the students gave the answer when she asked what number they should “multiply”. While the students realised this mistake, none of them was brave enough to point out to the teacher and the teacher did not realise her mistake until the end of the lesson.

In this section, errors made by the teachers were presented and discussed. Although most of the errors were minor, there were a couple which created confusion among the students. Since this research was not intended to focus on error and their analysis, the examples presented were only general observations made by the researcher. These errors were not addressed during the stimulated recall sessions to avoid embarrassment on the part of the participants. The occurrences of some errors may have been an indication of teachers’ limited competency in English language. This supports the evidence from the study by

Isahak et al. (2008) demonstrating that Malaysian mathematics teachers' level of proficiency was still low, overall. In fact, this factor has been cited by the researchers as one of the reasons why the teaching of mathematics in Malaysia should not be done in English.

6.4. Conclusion.

In this chapter, the language aspect of the data has been presented and discussed. The issues in focus were the use of L1 in teaching and the language errors made. A number of conclusions can be made from the findings. Teachers used L1 to achieve different purposes in their teaching. The teachers felt that it was necessary to fulfil the set teaching objectives, and this was reflected in their interview responses. In most instances, the use of L1 was seen as the resource in teaching to help them meet the learning needs of their students. For example, L1 was used by all teachers when they felt that students did not understand their explanations in English.

However, the overall use of L1 by all the teachers was still less than their use of L2. A problem which arose when teaching was done in the second language was the occurrence of errors made by the teachers. While most of the errors were minor, one or two major mistakes caused confusion and misunderstanding among students. While some of the errors described were considered as minor errors, the occurrence of major errors is a cause of concern because major errors may hamper students' understanding of the lesson. This is a problem that should be addressed through professional development.

CHAPTER SEVEN

DISCUSSION

7.0. Introduction.

The findings for this study were presented in Chapters Five and Six. In Chapter Five, the patterns of the teachers' classroom discourses were presented. Language issues such as using first language in teaching and errors in using second language were later presented in Chapter Six. This chapter presents further discussion of the results. The discussion is framed around the research questions listed in Chapter One.

7.1. Research Questions.

In this section, the research questions posited at the beginning of this research are used as the framework for discussion.

7.1.1. What was the nature of the use of mathematics register by teachers in teaching mathematics in English?

The term *mathematics registers* means words used specifically in communicating mathematical concepts. A number of researchers have argued that mathematics register is a crucial part of learning mathematics (e.g. Cuevas, 1984). A study by Pandian and Ramiah (2003) on mathematics teachers in Malaysia showed that seventy percent of them were aware of the existence of mathematics register. However, further interviews with the teachers in that study showed that

they did not know the specific features of the register (Pandian & Ramiah, 2003). Studies by Kamsilawati (2005) and Nursherrina (2005) also showed a similar finding: those teachers were not aware of the mathematics register.

In the study reported in this thesis, teachers were aware of mathematics terms especially the ones which were crucial to the observed lesson. For example, Amirah was aware that understanding the concept perimeter was central for the unit she was teaching. In order to make sure the students fully grasped the concept, she explained the term a few times in different situations. She also used L1 to explain the concept (Transcript 1, stanza 18) and the reason she gave for doing this was to make sure all her students understood the concept.

Another teacher from the same school, Aisyah, used the teaching resource (software) provided by the Ministry of Education to help explain the concept, measurement. She then translated parts which she felt crucial to the lesson such as the measurement units.

Amni, the third teacher, avoided using L1 in her explanation of mathematical concepts. Her strategies involved drawing and using real objects. For example, she used scales and weighed a number of things to introduce the concept, mass.

Aryana who was teaching a younger group of students used shapes made out of cardboard to illustrate 2-D shapes. She also asked her students to say the name of the shapes repeatedly. Based on the observations, it was concluded that the teachers in this research knew the importance of mathematics register in the

learning of mathematics and applied certain strategies to help the students gain understanding.

However, the findings of this research showed that the use of mathematics registers by all teachers was quite limited. Mathematics register was used mainly in procedural mathematics discourse. Mathematics terms were used mostly by the teachers when they were showing examples of how to carry out mathematics exercises and when discussing the steps to take in solving mathematics problems. While the teachers also used mathematics register in presenting the mathematical concepts to the students, the use of mathematics register in conceptual discourse was not as high as the procedural discourse.

The work of Khisty (2000) and Setati (2005) outlined in detail in Chapter Two is relevant to the discussion of the type of discourse used. Both researchers found that the discourse pattern which dominated the lessons was procedural discourse. Hence, the findings of this research support those of the previous research. This was consistent for all the four teachers observed in the study reported in this thesis.

Adler and Setati (2000) also suggested there was a correlation between the use of different type of discourse and the choice of language by teachers. The researchers found that teachers used English (L2) for procedural discourse when performing formal calculations. The first language was used for informal conceptual discourse. In this research, a similar situation was observed where teachers would use English more often for procedural language. This finding was evident for three of the participants, Amirah, Amni and Aryana. Aisyah, however,

used more L1 than others in discussing the mathematics procedures with her students in line with her habit of translating most of her explanations. She was the youngest teacher among the participants. Her lack of experience may have been a factor that contributed to a possible lack of confidence that the students could understand her delivery of her lessons. During her stimulated recall sessions, she said that the use of translation helped her students understand better. The research also showed that teachers would revert to L1 when explaining concepts. This result supported the findings by Pandian and Ramiah (2003) which showed that eighty-one percent of the teachers admitted to using L1 when explaining difficult concepts to the students.

In terms of regulatory discourse, Khisty (2000) found that the teachers used L1 to call for attention, to reinforce instructions and to give encouragement. Setati's (2005) findings were similar to those of Khisty, and she concluded that teachers used L1 to support and advise the learners. In this case, L1 was used as the voice of solidarity (Setati) or mark of solidarity (Khirsty). In a way, the use of L1 for regulatory discourse in this research was similar to the findings of Khisty (2000) and Setati (2005). The teachers were observed using L1 when reinforcing instruction or reprimanding the students as in the case when Amirah scolded her students for not doing homework (Transcript 2, stanza 26). However, the teachers observed in this research used English (L2) when giving encouragement to the students.

There are several conclusions that can be made from this research regarding the nature of the use mathematics register by the teachers. First, the teachers were

aware of the importance of mathematics register and that they should highlight it in their lessons. However, their use was very limited, confined to some mathematics terms only, and did not include the richness of mathematics register as defined by Gee (1996) or Meaney (2006). This is evident when teachers only focused on specific terms, used mainly as part of procedural discourse. This pattern was associated with the lesson objectives that the teachers set and the type of mathematical questions teachers expected their students to solve. For instance in most questions students were not required to provide reasons, hence, the lack of reasoning, or conceptual discourse used during the lessons. Second, the teachers' classroom discourse was made up of a mix of mathematics and non- mathematics language which were very integrated and not easily separated.

Third, both L1 and L2 were used in the teaching. However, the choice of language correlated with the type of discourse the teachers used. The teachers used mostly L2 for procedural discourse and used L1 for explaining concepts and regulating the class.

It was also established from the literature that teachers play an important role in helping students to acquire mathematics terms. A study by Khisty and Chval (2002) showed that students often 'mirrored' their teachers' discourse. White (2003) suggested that teachers use discussion to provide the context for students to practise using the register. The findings of this research were unable to confirm the impact of the teachers' discourse on students because the students were not the focus of the research.

7.1.2. How did the teachers explain and develop mathematics concepts in their lessons using English?

The explanation and development of mathematics concepts are important not only for students to be able to solve mathematics problems but also for them to be able to gain fluency in the language of mathematics. A competent student is the one who can do mathematics as well as talk about it.

This study looked at the way mathematics concepts were explained and developed by the teachers. Each teacher was observed teaching a whole unit for two weeks. The observations were important in order for the researcher to get a clear picture of the development of the unit. In general, the results showed that mathematics concepts were explained and developed using both the first and the second languages. The practice among the teachers varied. Amirah started explaining the concepts in her first lesson in English. As the lessons developed further and the exercises became more complicated, she would revisit the concepts, but this time she translated into Bahasa Malaysia to ensure students' understanding. She was also observed paraphrasing explanations to her students. Aisyah, on the other hand, would translate her explanation immediately after she gave it in L2. She also made use of the software provided by the Ministry of Education to help her with the explanation. However, she also would stop the software from time to time to translate what was being said into L1. Amni used mostly L2 for her explanation of concepts. She also used a number of resources to help her, for example, she brought the scales and fruits to explain to the class about mass. She also used the software provided but did not offer any translation for the students. Aryana

presented the concepts of two dimensional shapes using L2. She also used familiar objects around the room, such as the table and the blackboard, to point out to the students. She asked different groups of students to repeat the shapes' names a few times. She also used other familiar things to help the students remember the concepts, one example being relating the word "August" to the number of sides of an octagon.

As mentioned earlier in the findings (Section 5.3.5), the teachers seemed to follow a similar lesson structure which incorporated the teacher presenting the knowledge, and students practising answers to questions .There was a lack of variety in the teaching and learning activities and all discussion was led by the teachers. Furthermore, the students in this study seldom did more than give answers to the questions posed by the teachers. This scenario could be attributed to the common teaching approach in Malaysia, which is teacher-centred. The results of the study by Aman and Mustaffa (2006) discussed in Section 3.1, were similar to this study. According these researchers, throughout the lessons they investigated, there was limited involvement by students since discussion and problem analysis were not encouraged by the teachers. Consequently, there was lack of creative and critical thinking on the part of the students. Instead of being able to communicate mathematical concepts, students' use of mathematics register was confined to mere reproduction of some mathematical terms taught by the teachers.

In this research, the teachers used both languages, L1 and L2, in explaining mathematics concepts. Apart from that, the teachers also used different strategies to make sure that the students understood the important concepts. While the choice of

language varied among the teachers, all teachers were observed following a similar lesson structure. In fact, the same structure was observed by Aman & Mustafa (2006) during the Malay Language lesson they investigated. This suggests that many teachers in Malaysia follow an almost similar lesson structure, which for most parts is teacher dominated. Almost certainly, this structure is related to the education system which is exam-oriented and teacher-centred.

7.1.3. Did the teachers use specific teaching strategies in teaching mathematics in English?

The teachers who participated in this study used a number of strategies in teaching. In looking for the strategies used by the teachers, Meaney's (2002) list of strategies in her MRA model was used as a guide. Meaney's list deals specifically with the acquisition of mathematics register by students. In comparing the data with the list, strategies used by the teachers were identified.

In this study, teachers used repetition, modelling and scaffolding as the main strategies in teaching. Repetition was used by the teachers in various ways by the different teachers. Amirah repeated important information or concepts such as "perimeter" in different ways. She paraphrased the definition and also translated it into L1. The repetition occurred at different times. Aisyah and Amni made the students repeat words after them. Aryana, made different groups of students repeat the same word. It was interesting to note that the strategies varied according to the age of the students. Amirah, who was teaching the oldest group of students, did not ask the students to repeat the words after her. Rather, she repeated the definition for a number of times. Aisyah and Amni were teaching the students of the same age,

ten years old. Both teachers used the strategy of asking the students to repeat the words that the teachers felt were important for the lessons. Aryana, who was teaching the youngest group of students, nine year olds, made the students say the words repeatedly. This strategy, repetition, was observed mostly in Aryana's first lesson, which confirmed the claim made by Meaney (2006) that this strategy is prevalent especially at the noticing stage. At this early or noticing stage, repetition helps to expose the students to new terms and their correct usage.

Meaney (2006) also made a useful distinction between modelling and scaffolding. According to Meaney, modelling occurs when teachers use mathematics register in an appropriate context, while scaffolding is when teachers prompt students' utterances of the mathematics register. Based on the definition, it could be said that the teachers observed in this study used mathematics register in the appropriate contexts, hence they provided modelling to the students. However, there were instances when teachers mistakenly pronounced words, such as "management" instead of "measurement". This mistake caused confusion among students because the words have different meanings. It is concerning that this situation means that scaffolding strategies can be compromised because of basic errors in the use of English. For most of the time, teachers repeated word or terms that they felt important to the lessons. However, they also rephrased and simplified difficult words for the students. Amirah was observed prompting her students to produce the correct mathematics terms. This strategy was not present in the other teachers' lessons. The reason for this might have been related to the age of the students and teacher's proficiency in English.

Yuliati (2008) added that any contextual support to the meaning of words provided by the teachers was a part of scaffolding strategy. This support can include simplified language, modelling and the use of diagrams. In this research, Amirah used simplified language in explanation of mathematics concepts while Amni drew diagrams to convey the meaning.

Another strategy which was used by the teachers was calling for students' attention whenever they wanted to present an important concept. This was normally done in English unless students ignored the instructions, in which case, teachers would revert to Bahasa Malaysia.

The use of code switching is yet another strategy identified in several research studies. Setati (2005) and Moschkovich (2002) suggested that the use of L1 by the teacher who shared the same language with the students should be considered as a teaching strategy. Moschkovich stated that code switching is a cultural norm, the use of which depended on a number of factors: the speakers being addressed, the setting, the types of activities and the learners' experience with mathematics instructions. Setati and Adler (2000) found that English was used more in the public domain. Similarly, in this research, the teachers were observed using more English when they were addressing the whole class rather than when they were with a small group .The observations made during this study provided evidence to show L2 (English) was used by the teachers in the formal situation: the public domain of the classroom. In addition, L1 was used as a teaching resource by the teachers when they were interacting with the small groups to provide further explanations, to help the students understand.

In terms of differences in practice among teachers from different schools, Setati and Adler (2000) also found that code switching was observed less often in the rural areas than in urban areas and more in the additional language learning situation than in the foreign language situation. They attributed this observation to the fact that in a rural area in a foreign language situation, students are less exposed to English (L2). In this scenerio, students tend to rely heavily on their teachers for L2 input. Thus, the teachers see it as their obligation to model the correct use of L2. In this study, of all the teachers, Amni was observed using code switching least (refer to Table4.4). Aisyah, who was teaching in an urban school, used code switching the most. For the most part, the teachers' use of code switching matched the findings of Setati's and Adler (2000) in theri study. However, Aryana, who was teaching in the same rural school as Amni used code switching more often than Amirah who was teaching in an urban school. This teaching behaviour may be attributed to the teachers' sensitivity to their students' language proficiency. For example, Aryana admitted that her students had lower proficiency in English (Stimulated Recall 8, Line 14).

Where multilingualism and the use of code switching is concerned, it was stated in Section 2.6 that code switching is common when the teacher and the students share the same first language. While it might be expected that a teacher who teaches monolingual students and shares the same L1 with the students would use the code switching the most, it was not the case for all the teachers in this study. Amni, a Malay teacher who taught all Malay students, used code switching less often than Aisyah who taught a more multilingual classroom.

Eventhough it has been established that code switching is a useful strategy, Kasule and Mapolelo (2004) warned educators against overreliance on code switching. This was because there is no evidence to show how the strategy is helpful, and how much code switching should be allowed before it actually becomes detrimental to learning. The teachers being interviewed in this research stated their awareness of the obligation to teach in English, for example, as in the interview with Aryana (Stimulated Recall 8, Line 16). Ong and Tan (2008) in their study found that the students' level of English proficiency had a significant impact on the teachers' usage of code switching.

In conclusion, all the teachers observed used a number of strategies in their teaching of mathematics in a second language. Among the strategies were scaffolding and code switching. Scaffolding took different forms ranging from the use of repetition to introduce a new mathematics term to the use of diagram to illustrate the meaning of mathematics term. Code switching was observed to be common strategy used in the explanation of concepts. This impact of these strategies on the students could not be observed directly as the students were not the focus of this research study.

7.2. Professional Development.

In Section 3.5, the professional development programme (ETeMS) for training mathematics and science teachers to teach in English was discussed. Apart from presenting the theory and the structure of the programme, the challenges in its implementation was also discussed. In addition, the structure of the programme was

compared with some characteristics of effective professional development as recommended by a number of researchers in the field including Guskey (2003) and Loucks-Horsley (1996). While this research did not focus on professional development, it was important to consider any impact the ETeMS professional development programme may have had on the teachers since all of them had undergone this training.

During the pre-observation interview, the teachers were asked about their perspective of the ETeMS professional development programme they had experienced. Generally, all the teachers felt that the professional development sessions were useful because they provided linguistic input related to teaching of mathematics in a second language. However, all of the teachers agreed that the programme did not help to boost their confidence to teach mathematics in English. The teachers felt that more time should be given to them to allow them to practise using their English. Aryana suggested that more follow up courses should be carried out as support for the teachers.

In general, the teachers participating in this research demonstrated a response to the ETeMS professional development programme similar to that made by other teachers and reported elsewhere (e.g. Hamidah et al., 2005; Noraini Idris et al., 2007; Pandian & Ramiah, 2004). The ETeMS professional development programme was seen as a useful programme. However, it was felt there were a number of issues that needed to be addressed through more training. The teachers interviewed in this research pointed out that the opportunity for them to practice teaching would be helpful especially in developing their confidence to teach in English.

While one of the teachers mentioned the ETeMS during the interviews, observations of the lessons during the study provided some evidence to support possible

connections between the ETeMS programme and the teachers' practices. For example, the language errors made by the teachers seem to suggest the inadequacy of this professional development programme to support their development of sufficient proficiency in using English to teach mathematics. While the aim of the ETeMS professional development was to provide language input so that teachers could teach in English, it was clear from observation that the professional development sessions failed to address the language fluency problem adequately among mathematics teachers.

After the ETeMS professional development sessions had been completed, teachers were provided with the courseware as a teaching resource. Three of the teachers used the courseware, each of them using it during their first observed lesson, mainly to help introduce the concepts to the students. Sam et al. (2009) reported that new teachers experienced problems using the courseware and that they struggled to explain the content of the courseware to the students. In this research, the new teacher, Aisyah used the courseware for the same purpose as the other two teachers, Aryana and Amni, that is, to explain mathematics concepts. She was not seen struggling with the explanations as such, but she was often observed translating the explanation provided into Bahasa Malaysia.

Given the immediacy of the implementation of the language policy, ETeMS may be considered as a useful programme that provided support for teachers to begin teaching in English quickly. However, evidence from the teachers' classroom discourse gathered during this study, suggests that a lot more needs to be done to continue the professional development of the teachers and thereby increase the chances that the policy change will be a success. First, teachers' own English language fluency needs to be improved as this will ensure effective delivery of the lesson. Higher proficiency will decrease the

incidence of errors meaning in turn, that teachers' will be better able to use scaffolding and code switching strategies in more confident and effective ways. Second, teachers' knowledge of their students' level of English proficiency needs to be addressed as well. If teachers understand their students' language learning needs as well as their mathematical learning needs and are able to diagnose and provide for those needs, student learning will be facilitated more effectively.

7.3. Language Policy.

The change in language policy from teaching science and mathematics in Bahasa Malaysia to teaching these subjects in English was a major educational change for the country. This research was conducted based on the assumptions that language is important for transmitting knowledge and teachers are the agents of any educational change. When this research began, the ETeMS professional development programme was in its initial stage of implementation, coinciding with the imperative that the policy was put in place very quickly. The research was not carried out to evaluate the policy as such, rather to investigate how the teachers used teaching strategies to teach mathematics in English.

The findings of this research have shown that teachers were able to conduct their classes in English using strategies including code switching and the use of teaching resources such as reading sheets, diagrams and the courseware provided by the Ministry of Education. However, the research also found that teachers' English language competency needs to be improved. This is reflected, for example, in the errors they made which were discussed in Section 6.3.

As mentioned earlier in Chapter One, the teachers who were teaching mathematics in a second language had a demanding task of having to teach in a language that students were still learning and that was not their first language. This is a particularly challenging situation for teachers and seemed to be a heavy task for the teachers observed in this study. The teachers were all qualified mathematics teachers and all of them had at least seven years of teaching experiences. However, the language problems sometimes hindered them from performing their best as reflected in the mistakes they made while teaching. It should be noted that while these teachers were qualified and experienced mathematics teachers, they were not language specialists. Therefore, they were not qualified to handle language problems. As was pointed out in the previous section, it was clear that these teachers need further training in English and a lot of support especially during the transition period. While the ETeMS professional development programme helped the teachers, more support should have been given after the programme was completed. The development of language takes time and cannot be addressed within one relatively short professional development programme. This is especially important in this context because Bahasa Malaysia has been used as the language of instruction for over twenty years, hence the teachers and students have better competency in Bahasa Malaysia than in English.

In discussing the Malaysian education system, it was noted that much emphasis is put on examinations. This exam-oriented system has resulted in a certain teaching approach being used by the teachers. Lessons are mostly teacher-centred with a focus on topics tested during the examinations. Teachers, as well as the students are pressured to produce good exam results. Therefore, most of the lessons are focused on preparing

students for the major examinations. In line with this, the teachers observed in this study used mostly procedural mathematics discourse in teaching. This perhaps was not surprising as the exams students are expected to undertake do not demand the reasoning behind answers to be demonstrated. The assessment format and intended learning outcomes were cited by the teachers during the stimulated recalled sessions, as the factors which caused the overuse of one discourse type over another. A change in language of instruction does not mean only changing the language but also changing the curriculum and assessment format to be in line with the objectives of the policy change. Therefore, the language change should have been accompanied by changes in the curriculum including assessment. As stated earlier, competent mathematics students should be able to provide justifications for responses to mathematical problems. Thus, a main aim of mathematics teaching should be for students to communicate mathematically. Assessment should not focus only on the students' ability to provide correct answers but also on their skills to give reasons for their answers. Students' ability to provide reasoning is important to indicate that they are developing mathematical competence.

In the earlier discussion in Section 2.6, the dilemma regarding the use of code switching was raised. While many researchers including Moschkovich (2002) and Setati (2005) advocated the use of code switching as a teaching strategy, the use of code switching has not been encouraged in the Malaysian context. Researchers have tended to relate the frequent use of code switching to the teachers' lack of fluency in the language (e.g. Isahak et al. 2008): teachers use L1 to compensate for their lack of vocabulary in L2. However, the teachers who participated in this research felt that they needed to use L1 to ensure that their students understood the mathematical concepts they were encountering

and were able to proceed with the lessons. Three of the teachers, Amirah, Amni and Aryana, used L1 whenever they felt that their students could not understand their lessons. Aisyah used more L1 than the others. Due to her lack of teaching experience, she was not able to tell whether her students understood her lessons resulting in her translating most of her lessons.

During the stimulated recall sessions, the teachers were asked to provide reasons for their choice of language. While there were a number of factors which might have influenced teachers in making their decisions, they maintained that their students were their central concern. For example, the teachers decided to use L1 to explain mathematical concepts so that all the students would understand them. This finding is similar to that found by Yahaya et al. (2009), in which teachers said that students' low English proficiency was the main cause for the use of L1 in the classroom. However, there is always the dilemma of how much L1 should be used in teaching. Considering that one of the main objectives for using English to teach mathematics and science in Malaysia was to increase students' proficiency in English, logically overuse of L1 in teaching would defeat this objective. The teachers in this study realised the importance of providing their students with good models of language use but at the same time they had to make sure that the understanding of the mathematics content was not compromised. Getting the balance right is a continuing challenge.

A change in language policy takes careful planning because it involves more than a mere change of language. The effects of the change need to be looked at in terms of the whole curriculum including assessment. More importantly, and perhaps the most difficult aspect to change are teachers' beliefs and their classroom practice. In the case of

Malaysia the lack of competency among teachers and students means that implementation of the policy may take a longer time to succeed. More time should be given for the transition into the new policy.

7.4. Conclusion.

This chapter discussed the results of the research using the research questions as a frame for that discussion. Three key points were made. First, teachers were aware of their obligation to provide students with specific mathematics language. The teachers employed a number of strategies to make sure their students understood important mathematics terms. Among the strategies used were repetition, modelling, scaffolding and code switching. The teachers believed that their strategies were helpful to the students, but the use of code switching remains controversial. The use of code switching could be seen as evidence of teachers' lack of proficiency in English. Second, the discourse patterns which emerged from the findings of this research were related to the structure as well as the objectives of the observed lessons. The high use of procedural discourse suggested the limited emphasis teachers put on the students' ability to explain the reasoning behind solutions to mathematics problems. This emphasis was also consistent with the structure of the lessons which tended to be mostly teacher-centred. While there were similarities among practices of teachers in this study, each teacher had her own unique way of presenting her lessons. Finally, the results also showed that teachers could teach in L2, but with more support and time the teachers' ability to use L2 for teaching mathematics and cater for their students' language and mathematics learning needs would improve. The occurrences of language errors observed during the lessons

suggested the need for more professional development to enhance the teachers' second language proficiency as well as their teaching practices.

CHAPTER EIGHT

IMPLICATIONS AND RECOMMENDATIONS

8.0. Introduction.

This research has a number of implications and recommendations for the Malaysian education system especially for those who are involved directly with the change in language policy including policy makers, teacher educators and teachers. Before discussing these implications and recommendations, the limitations of the research are described.

8.1. The Limitations of the Research.

When this study began, the implementation of using English for teaching mathematics had just begun in Malaysian schools. The decision to investigate the impact of this policy change for classroom practice was made because Malaysia provided a new context for studying the teaching of mathematics in second language. Furthermore, as a teacher educator, I have a strong interest in this topic. There were a number of limitations which affected this study including the duration, the participants and the change in policy. Since this research is a case study, the result is true for the given context. The findings have been presented in a way that teachers and researchers in different contexts, faced with similar issues in the field of teaching mathematics in L2 , will find them of use. However, discussion of the limitations is important for future studies in this area.

8.1.1. The duration of the study.

The data gathering phase of this study was carried out for one week with each of the four teachers in 2009. Since the change in language of instruction was done in phases and was only completed in 2010, the study was undertaken during the transition period of the change. The results obtained from this study only reflect the situation at the time of the research, which was four years after the language policy was implemented. There is a need for future research after the changeover period is completed to see if classroom practice has changed. By this time, the teachers would have gained more experience teaching in English, and that factor might have an impact on their teaching ability, especially on their use of teaching strategies.

8.1.2. The participants.

The participants were chosen among mathematics teachers who had undergone the ETeMS training course and who were teaching mathematics in English. The two schools selected were typical schools situated in rural and the urban areas in Malaysia. The selection of participants was done on the basis of suggestions from the principals of respective schools. However, this selection resulted in having all the participants from the same gender, female and race, Malay. A variation in gender and race may produce different results especially in the use of L1. People of difference races speak different L1.

As with all case study-type research, claims made as a result of this work are not necessarily transferable to all other situations and contexts. Teachers differ from one another in their practice and there are many factors such as students' age

which have an impact on teaching methods. The results from this study described what happened during specific lessons conducted by specific teachers in specific classrooms as well as variations in the wider institutional and educational context. Although the study has provided some insights into the teachers' classroom practice such as their use of specific teaching strategies, they cannot be generalised to other situations. However, the detail provided in this thesis will enable other researchers and readers to make connections with their own situations and therefore make use of the findings in ways that are appropriate for their educational contexts.

8.1.3. The policy change.

The change in language of instruction for teaching of mathematics in Malaysia took place in 2003. The planning for this research began in 2007 and data were collected in 2009. However, in late 2009, the Ministry of Education announced another change in language of instruction, which made Bahasa Malaysia, the language of instruction for teaching of mathematics starting with Year One students in 2010. By the year 2012, all students will be learning mathematics in Bahasa Malaysia. This change does not render this research irrelevant. The findings of this research have relevance for the issues in teaching of mathematics and other subjects areas in a second language particularly in the use of teaching strategies by teachers who have to teach in their L2. However, similar research could no longer be replicated in the same situation because of the change in education policy.

8.2. Implications and Recommendations.

As noted earlier in Chapter One, teaching mathematics in a second language is a new area of research. In the past, many people, including mathematics educators and researchers, believed that language was not an important part of mathematics education as mathematics dealt mostly with numbers. Only recently, researchers in this field agreed that being mathematically competent includes being able to do mathematics and to talk about mathematics. More research needs to be conducted to look at the impact of language in mathematics education, especially when students have to learn the subject in a second language. In general, the findings from this study contribute to the field of teaching mathematics in a second language as they may inform those interested in the field about the classroom practice of the teachers. This information can be used to assess teaching and learning processes as well as design appropriate training for teachers. This is a situation where teachers have to teach mathematics in their second language to the learners who are also learning in their second language. This is an education context which is prevalent in many developing countries like South Africa and Papua New Guinea. The situation in Malaysia, however, was different from others because only mathematics and science subjects were taught in the second language, English. Other subjects were taught in Bahasa Malaysia. Given the unique situation in Malaysia, this research may specifically contribute new knowledge for teaching of mathematics in a second language in Malaysia, as well as being of interest in other contexts where Mathematics is taught in English is not the first language. In the section that follows, more specific implications of this research for teachers, teacher education and policy makers are discussed.

8.2.1. Pedagogical implications.

This study examined the language used by the teachers in teaching mathematics in their second language, English. There are a number of significant findings which have direct implication to the practices of teaching of mathematics in a second language, especially in Malaysian contexts.

Firstly, most activities done during the observed lessons were teacher-led and the focus of the lessons was more on students' ability to do mathematics rather than communicate mathematically. It was evident that teachers used mostly procedural discourse in the class. This observation was similar to the findings by other researchers (Khisty, 2000; Setati, 2005). One of the reasons given for this seemed to be the lack of variety in classroom activities and the teacher not providing adequate opportunities for students to discuss mathematical ideas with each other in class. This was a result of the teachers complying with the lesson's objectives as well as the assessment format. It has been established through the discussion in Chapter Two, that to be mathematically competent, students should be able to talk about mathematics, for example provide reasoning for certain calculations and answers given. To achieve this goal, teachers should make sure that students are given the opportunity to talk about mathematics in class. Teachers must vary the activities in the classroom to include activities which encourage students to provide reasons and discuss the answers.

Another reason behind the teacher-centred lessons that were observed is the fact that the teaching was done in English, the second language of the teachers and students. The teachers observed in this study were experienced teachers with

seven to twenty-three years of teaching experience. However, the results of this study showed that the language constraint affected the teachers' delivery of mathematics content. The occurrences of language errors indicated the teachers' lack of proficiency in English. During the interviews, teachers also voiced their concerns about the students' level of language proficiency. They admitted that their student were weak in this regard which was why they had to use L1 from time to time. The students' level of English not only affected their understanding of the lessons and their ability to used L2 in doing mathematics, but it also affected the teachers' decisions about whether to use L1 or L2.Therefore, the language constraints inhibited the teachers and students from doing activities such as mathematics discussion in the classrooms.

However, the teachers in this study felt that the use of L1 or code switching was essential as one of the teaching strategies to enhance students' understanding. It is interesting to note that at the noticing stage, all the teachers used English to introduce new mathematics terms and concepts. This observation shows that the teachers were aware of the need to provide students with the correct use of the terms in L2. Other teaching aids such as 3D shapes and diagrams were used as scaffolding strategies. The use of code switching was observed in later lessons especially when the students needed to do calculations. During the stimulated recall sessions, the teachers explained that the use of L1 at this stage was important to ensure understanding so that the students would be able to carry out the tasks given. This indicated that code switching was not used mindlessly by the teachers; rather it

was used as a result of a conscious decision made by the teachers as a teaching strategy.

The outcomes of this research imply that teachers need to change their teaching methods to give the students more opportunities to use English in learning mathematics. This change will help in making the students more competent in mathematics. Students can be encouraged to discuss and talk using mathematics language during mathematics lessons.

There also needs to be more support for teachers to make this pedagogical change. Mathematics curriculum has to be changed so that the lessons objectives and the assessment format would allow teachers to vary their teaching methods. Besides providing the teachers with the language proficiency course, they also need to be exposed to different strategies to teach mathematics in English. It will help them to choose the strategies to suit their students and become competent mathematics teachers.

8.2.2. Implications and recommendations for teacher education.

Providing teachers with effective professional development programmes is crucial to ensure the smooth implementation of a policy change process. In the case of Malaysia, ETeMs was the first professional development programme offered to all mathematics and science teachers as soon as the policy change was announced. For a start, ETeMS seemed to be a successful programme to help teachers to teach in English as indicated by the teachers in this study during the interview. However, the results from this study showed that there is a need for further professional

development programmes with particular focus on the development of teachers' English language proficiency. Furthermore, teachers should be exposed to second language acquisition theories and pedagogies related to second language teaching as suggested by Lucas et al. (2008). So far, ETeMS was carried out to address the teacher's language proficiency problems to enable them to teach in English. There need to be professional development programmes which provide teachers with skills to understand the language that students need to carry out activities in classrooms and other teaching strategies which enable students to participate successfully in classroom activities. Teachers should be exposed to code switching through professional development programmes so that they are aware of the fact that code switching does not necessarily reflects their incompetency in the second language. Instead, they have the choice of using code switching as a strategy as long as they do not overuse it. This way, the teachers would not feel guilty every time they use it in class.

Although the ETeMS training programme was carried out to address mathematics teachers' language proficiency to help them teach in English, a number of studies conducted on the effectiveness of this programme (Hafiz et al,2003; Gill,2009; Ong &Tan,2008) indicated that the programme needed to be improved. Ong & Tan (2008) pointed out that the teachers have different levels of language proficiency. A similar, nationwide course for all teachers did not address the proficiency problems. Hafiz et al (2008) suggested that different course modules should be used for different groups of people. The results of this research also support the suggestion. The professional development programmes design for

the mathematics teachers should be able to cater to the different linguistics needs of the teachers. This programme, will in turn help build up the teachers' confidence to teach in their second language.

The language support for these teachers should also be continuous at least during the transition period. A study by Yahaya et al. (2009) showed that teachers admitted to having no time to use the support materials provided. They also asked for help from their *buddies* only when they had vocabulary or grammar problems. This support programme should actually extend beyond the initial phase of implementation and provide teachers with opportunities to engage in professional development through ongoing practical application including collaborative planning of the lessons.

The process of teacher change takes time. It does not happen after just one professional development programme. There needs to be follow-up courses for the teachers to help them embed their learning into their everyday teaching practice.

More importantly, teachers should be exposed to research and development in this area so that they can make informed decisions about their practice. This can be achieved by attending conferences and short courses at national and international levels. They can also carry out research in this area in their own classrooms.

8.2.3. Implication for policy change.

The implementation of the language policy change was done hastily. Teachers' limited competency and confidence to use English to teach mathematics suggested a lack of preparation to implement the policy change. Training needs analysis and other research related to the field should be conducted prior to the

implementation of the policies such as this language policy. The needs analysis would help in designing appropriate professional development programmes which provide customized support to meet the needs of different groups of teachers.

Furthermore, more time should be given for the teachers to accept the change because the teachers need to see the results, particularly in terms of improved students' performance, in order to change their practice. So far, the language of instruction for teaching mathematics in Malaysia has been changed twice within a period of seven years. The policy makers need to acknowledge that a change in language policy does not involves language only. Policy changes should be a accompanied by relevant changes to curriculum, including assessment. Policy makers should also recognise that long term support for teachers is required to ensure teachers are equipped to implement the change effectively.

8.3. Further Research.

Considering the limitations of this study, there are a number of areas that could be further explored in future research.

First, this study focused on classroom discourse used by a small group of teachers at a specific time. A longitudinal study which follows a teacher's activities over a longer period of time would be useful to examine possible changes in the teacher's practice in the longer term and also the effectiveness of professional programmes.

Second, similar research could be carried out at different levels of education including secondary and tertiary levels. Teachers at secondary schools and tertiary institutions in Malaysia have different qualifications from the primary school teachers. It

would be interesting to examine whether this factor has an impact on their classroom discourse practice.

Third, future research could also focus on learning mathematics in a second language. There are a number of factors which contribute to a student's success as a learner of mathematics such as parental' support. The factors can be further examined if such research focuses on the student learning rather than on teacher learning.

8.4. Conclusion.

In general, this study confirmed the findings made by researchers in the field of teaching mathematics in a second language. Firstly, it supported Setati's & Khristy's findings on the dominance of procedural discourse in the mathematics lessons. This is expected as mathematics involved a number of explanations of process especially problem solving exercises. However, there is a slight difference in the use of L1. While the previous research found that L1 was used by the teachers as language of encouragement, the teachers in this study used L2 for the same purpose. L1 was used mainly to reprimand the students to call for attention.

Secondly, this study also found that the use of similar teaching strategies as shown in Meaney's MRA particularly in the initial stages. However, in the last stage, the output stage was not very clear in this study. This is because the students were not the focus of this study; therefore, the access to their work was limited. Furthermore, the activities in the classroom did not require the students to use a lot of mathematics language, rather they were only expected to provide the answers to the mathematics questions given.

In addition to the strategies mentioned by Meaney, this study also found that the teachers considered code-switching as a strategy to assist students' understanding especially in intake and integration stages. However, the researchers in Malaysia (e.g. Ong & Tan, 2008) see the use of code-switching as a sign of teachers' lack of fluency in L2. This is one of the reasons which prompted the Malaysian Ministry of Education to change the language of instruction for Mathematics.

While this study has some similarities to other studies, it does have its own uniqueness. First and foremost, unlike the situations in other countries, whereby L2, English is used as the language of instruction at school, in Malaysia both Bahasa Malaysia (L1) and English (L2) are use as the language of instruction in schools at the same time. This presented a complex situation as students as well as the teachers had to constantly switch from one language to another. This situation certainly had some impacts on the students in their attempt to grasp the content of the lessons in their L2. Therefore, the decision to use English to teach mathematics was a risky more to make considering the varying level of proficiency among teachers and students.

Secondly, this study also highlights difficulties faced by the teachers who have to teach mathematics in the L2. Although the teachers tried their best to comply with the policy, the presence of language errors reflects on their lack of proficiency in the language. Clearly, the teachers need more training and support to continue teaching in English. The findings of this study suggest that there need to be careful research conducted prior to the implementation of a new policy in education. In terms of training, the teachers would benefit from a smaller scale training which focus on different groups with different language abilities rather than a mass training. Lastly, the fact that the

language of instruction for teaching mathematics and science in Malaysia was changed from English back to Bahasa Malaysia, make it impossible to carry out a study like this again. This has added the value to this research.

With the increase in the number of multilingual classrooms context, this study into how teachers approach the new educational context may contribute to improving the teaching and learning process. A number of researchers have conducted similar studies in different multilingual contexts. This research, using a case study approach, has affirmed that there were similarities in teachers' discourse patterns in teaching mathematics in a second language. It has provided implications for the practice and support of teachers and for those in the position of introducing changes to language policies involving the teaching of mathematics in a second language.

REFERENCES

Abdullah, A. N., & Heng, C. S. (2003). Gaining Linguistic Capital through a Bilingual Language Policy Innovation. *South Asian Language Review, XIII* (1&2), 100-117.

Adetula, L. O. (1985). *The effects of language and schooling on the solutions of addition and subtraction word problems by Nigerian children*. Madison: University of Wisconsin.

Adetula, L. O. (1990). Language factor: does it affect children's performance on word problems? *Educational Studies in Mathematics, 21*(4), 351-365.

Adler, J. (2001). *Teaching mathematics in multilingual classroom.* Dortrecht: Kluwer Academic Publisher.

Aiken, L. R., Jr. (1972). Language factors in learning mathematics. *Review of Educational Research, 42*(3), 359-385.

Akindele, D. & Letsoela, M. (2001). Code Switching in Lesotho secondary and high school lessons and its effects on teaching and learning. *BOLESWA Educational Research Journal, 18,* 83-100.

Aman, I., & Mustaffa, R. (2006). Classroom discourse of Malay Language lesson: A critical analysis. *Jurnal e-Bangi, 1*(1), 1-23.

Arthur, J. (1996). Code switching and collusion: Classroom interaction in Botswana primary schools. *Linguistics and Education, 8,* 17-33.

Asmah, H. O. (1996). *Post imperial English in Malaysia*. Berlin: De Mouton Gruyter.

Asmah, H. O. (2003). *Language and language situation in South East Asia: With a focus on Malaysia*. Kuala Lumpur: University Malaya.

Atweh, B. & Clarkson, P. (2002). Globalized curriculum or global approach to curriculum reform in mathematics education. *Asia Pacific Education Review, 3*(2), 160-167.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27,* 10-20.

Barwell, R. (2008). Discourse, mathematics and mathematics education. In M. Martin-Jones, A. M. de Mejia & H. N. H. (Eds.), *Encyclopaedia of Language and Education, 3*, 317-328.

Barwell, R., Barton, B., & Setati, M. (2007). Multilingual issues in mathematics education: Introduction. *Education Study Mathematics, 64*, 113-119.

Bickmore-Brand, J.(1990). *Language in mathematics*. Melbourne, Australia: Australian Reading Association.

Bickmore-Brand, J., & Gawned, S. (1990). Scaffolding for improved mathematical understanding. In J. Bickmore-Brand (Ed.), *Language in mathematics.* (pp. 43–51). Melbourne: Australian Reading Association.

Bogdan, R. C. & Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods*. Boston, MA: Pearson Education Inc.

Bolam, R. (1987). *What is effective INSET?* Paper presented at the Annual Members Conference of the National Foundation for Educational Research, NFER, Slough. *Bulletin 84*(618), 6-12.

Borasi, R. & Agor, B. J. (1988, April 1988). *Potential impact of research in second language acquisition on mathematics instruction: The beginning of a conversation.* Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans.

Burns, R. (1994). *Introduction to research methods: Introduction to research methods in education.* Melbourne: Longman Cheshire.

Caroll, M. (2003, Dec. 2003). *Curriculum development as a social activity*. Paper presented at the ELTC ETeMS Conference, Kuala Lumpur.

Clarkson, P. C. & Galbraith, P. (1992). Bilingualism and mathematics learning: Another perspective. *Research in Maths Education, 23*(1), 34-44.

Clarkson, P. (2004, May 2004). *Teaching mathematics in multilingual classroom: The global importance of contexts.* Paper presented at the Globalisation Trends in Science, Mathematics and Technical Education, University of Brunei Darussalam.

Cook, V. (1991). *Second language learning and language teaching*. London: Edward Arnold.

Creswell, J. W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. New Jersey: Pearson Educational Inc.

Creswell, J. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. London: Saga Publication.

Cuevas, G. J. (1984). Mathematics learning in English as a second language. *Journal for Research in Mathematics Education, 15*(2), 134-144.

Cummins, J. (1979). Cognitive academic language proficiency, linguistic interdependence, the optimal age question, and some other matters. *Working Papers on Bilingualism, 19*, 197-205.

Cummins, J. (1980). The entry and exit fallacy in bilingual education. *NABE Journal, 3*, 25-59.

Cummins, J. (1981). Age on arrival and immigrant second language learning in Canada: A reassessment. *Applied Linguistics, 2*, 132-149.

Cummins, J. (2008).BICS and CALP: Empirical and theoretical status of the distinction. In B. Street & N. Hornberger (Eds.), *Encyclopaedia of Language and Education, 2*, 71-83.

Dale, D. C., & Cuevas, G. J. (1987) Integrating language and mathematics learning, In C. JoAnn (Ed), *ESL through content-area instruction* (pp 9-23). New Jersey: Regents, Prentice Hall.

David, M. K. (2004). *Language policies in a multilingual nation: Focus on Malaysia*. Frankfurt: Peter Lang.

David, M., & Sutton, C. D. (2004). *Qualitative interviewing in social research: The basics.* (pp. 85-100). London, California, New Delhi: Saga Publications.

Davidson, C., & Tolich, M. (1999). Competing traditions. In C. D. M. Tolich (Ed.), *Social science research in New Zealand.* (pp. 23-38). Auckland: Pearson Education New Zealand.

Donovan, Brian F. 1990. Cultural power and the defining of school mathematics: A case study. In *Teaching and learning mathematics in the 1990s,* ed. Thomas J. Cooney and Christian R. Hirsch. Reston, VA: National Council of Teachers of Mathematics.

Farrugia, M. T. (2003). The use of English as a medium of instruction in Maltese Mathematics classrooms: Continuing the debate. *Journal of Maltese Education Research, 1*(2), 1-14.

Farrugia, M. T. (2006). *Medium and message: The use and development of an English mathematics register into Maltese primary classroom.*, University of Birmingham, Birmingham.

Feryok, A. (2007). The impact of TESOL on mathematics and science teachers. *ELT Journal, 62*(2), 123-130.

Firestone, A. H. (1989*). A meaningful, rule-based, problem solving approach to teaching mathematics.* College of Education. Dunedin, Otago University. Master of Arts in Education: p. 134.

Foo, B., & Richards, C. (2004). *English in Malaysia*. London: Sage Publication.

Fraenkel, J., & Wallen, N. (2009). The nature of qualitative research. In *How to design and evaluate research in education* (pp. 421-437). Boston: McGraw-Hill Higher Education.

Ganser, T. (2000). An ambitious vision of professional development for teachers. *NASSP National Association of Secondary School Principals.*

Garegae, K. G. (2003, July 2003). *Language in mathematics education: Double jeopardy for second language learners*. Paper presented at the MERGA 2003.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915-945.

Gass, S. M. and A. Mackey (2000). *Stimulated recall methodology in second language research.* New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.

Gaudart, H. (1987). English language teaching in Malaysia: A historical account. *The English teacher, XVI* (Dec 87).

Gaudart, H. (1996). Some Malaysian bilingual student teachers: A profile. *Journal of Multilingual and Multicultural Development, 17*(2-4), 169-189.

Gawned, S. (1990). An emerging model of the language of mathematics. In J. Bickmore-Brand (Ed.), *Language in mathematics* (pp. 27-42). Carlton, Vic.: Australian Reading Association.

Gee, J. (1996). *Social linguistics and literacy: Ideology in discourse.* London: Falmer Press.

Gill, S. K. (2005). Language policy in Malaysia revising direction. *Language Policy, 4*, 241-260.

Gill, S. K., Nambiar, R., Ibrahim, N., & Tan, K. H. (2009). Globalisation and language-in-education policy shift in Malaysia: Challenges of implementation. In V. Vaish (Ed.), *Globalisation of Language and Culture in Asia*. London: Continuum.

Gorgorio, N., & Planas, N. (2001). Teaching mathematics in multilingual classrooms. *Educational Studies in Mathematics, 47*(1), 7-33.

Greenfield, P. M. (1984). *A theory of the teacher in the learning activities of everyday life.* Cambridge: Harvard University Press.

Griffee, D. T. (2005). Research tips: Interview data collection. *Journal of Developmental Education, 28*(3), 36-37.

Guskey, T. R., & Sparks D. (1991). What to consider when evaluating staff development. *Educational Leadership, 49*(3), 73-76.

Guskey, T. R., & Sparks D. (1996). Exploring the relationship between staff development and improvements in student learning. *Journal of Staff Development, 17*(4), 34-38.

Guskey, T. R. (2002). Professional development and teacher change in *Teachers and teaching: Theory and Practice, 8,* 381-391.

Guskey, T. R. (2003). What makes professional development effective? *Phi Delta Kappan, 84*(10), 748-750.

Hafiz, D. Z. A., Karuppiah, D. N., Ahmad, D. H. N., Harun, P. R., & Ibrahim, P. N. H. (2006). *Evaluation of the effectiveness of in-serviced training ETeMS*. Kuala Lumpur: Teacher Education Division, Malaysia Ministry of Education.

Hamidah, A. R., Nordin, A., Isa, M., Puteh, F., Muhammad, F., Majid, N. A., et al. (2005, Nov. 2005). *Teacher's competency in teaching mathematics in English in Malaysian secondary school.* Paper presented at the Mathematics Education into the 21 Century Project, Johor Bharu, Malaysia.

Halliday, M. A. K. (1975). Some aspects of sociolinguistics. In, *Interactions between linguistics and mathematics education, 74*, Paris: UNESCO.

Halliday, M. A. K. (1978). Sociolinguistic aspects of mathematics: a source of multicultural experiences. In M. Halliday (Ed.), *The social interpretation of language and meaning.* (194-204). London: University Park Press.

Heng, C. S., & Tan, H. (2006). English for mathematics and science: Current Malaysian language in education policies and practices. *Language and Education, 20*(4), 306-321.

Ho, W. K. (2002). English language teaching in East Asia today: An overview. *Asia-Pacific Journal of Education, 22*(2), 1-22.

Holton, D. and Thomas, G. (2002). Mathematics interaction and their influence on learning, *Mathematics Education Library, 25*, 75-105.

Hussein, A. (1990). *Effectiveness of teachers' preparation and professional development activities*. Paper presented at the National Conference of KBSR Implementation Evaluation: Malaysia Ministry of Education.

Ibrahim, R. (2007). Multicultural and education in Malaysia. *Culture and Religion, 8*(2), 155-167.

Ingvarson, L., M. Meiers, et al. (2005). Factor affecting the impact of professional development programs on teachers' knowledge, practice, student outcomes & efficacy. *Education Policy Analysis Archives, 13*(10): 1-28.

Isahak, H., Gapor, A. L. H., Masran, M. N., Ibrahim, A. H., & Nor, M. M. (2008). *The impact of policy of the teaching of science and mathematics in English in primary schools.* (No. 03-12-95-05): UPSI.

Ismail, H. R. (2003, Dec. 2003), *Welcome speech.* Paper presented at the ELTC ETeMS Conference: Managing Curricular Change, Pearl International Hotel, Kuala Lumpur.

Janzen, J. (2008). Teaching English language learners in the content areas. *Review of Educational Research, 78*, 1010-1038.

Jarrett, D. (1999). *The inclusive classroom: Teaching mathematics and science to English-language learners. It is just good teaching.* Portland: Department of Education, Washington, DC.

Johnson, B. & Christensen, L. (2004). *Educational research: Quantitative, qualitative, and mixed approaches*. Boston, Pearson Education Inc.

Jones, G. (2004). *The impact of 20 years of research: Research in mathematics education in Australasia 2000-2003.* B. Perry, G. Anthony and C. Diezmann. Queensland: Post Press.

Joyce, B., & Showers, B. (1980). Improving in-service training: The message of research. *Educational Leadership, 37*, 379-385.

Kamsilawati, K. (2005). *Teachers' perception of their level of readiness to teach mathematics and science in English (ETeMS).* Bangi: University Kebangsaan Malaysia.

Kasule, D., & Mapolelo, D. (2005). Teacher strategies of teaching primary school mathematics in a second language: A case of Botswana. *International; Journal of Educational Development, 25*(6), 602-617.

Kawulich, B. B. (2005). Participant observation as a data collection method. *Qualitative Social Research, 6*(2), 1-28.

Khalid, M., & Tengah, M. K. A. (2007, May 2007). *Communication in mathematics: The role of language and its consequences for English as second language students.* Paper presented at the 12th Annual Conference in Education ICE, Brunei.

Khiruddin, A. (2007). *Kolabrasi guru bahasa Inggeris dengan guru sains dan matematik dalam PPSMI di sekolah rendah.* Bangi: University Kebangsaan Malaysia.

Khisty, L. (2000). A Naturalistic look at language factors in mathematics teaching in bilingual classrooms. In *Proceeding of the Third National Research Symposium on Limited English Proficient Student Issues*: *Focus on middle and high school issues*, *2,* 633-654.

Khisty, L. L., & Chval, K. B. (2002). Pedagogic discourse and equity in mathematics: When teachers' talk matters. *Mathematics Education Research Journal. 14*(3), 154-168.

Kon, Y. H. (2005). Teaching efficacy beliefs of primary school teachers in using English to teach mathematics and science, *Jurnal IPBA, 3*(2), 45-49.

Krashen, S. (1982). *Principles and practice in second language acquisition*. Oxford: Pergamon.

Krashen, S. (1985). *The Input hypothesis: Issues and implication*. New York: Longman.

Krashen, S. (2003). *Explorations in language acquisition and use: The Taipei lecturers.* Portsmouth, NH: Heinemann.

Latu, V. F. (2005). *Language factors that affect mathematics teaching and learning of Pacifica students*. In P. Clarkson, A. Downton, D. Gronn, M. Horne, A. McDonough, R. Pierce, & A. Roche (Eds.), *Building connections: Theory, research and practice* (Proceedings of the 28th annual conference of the Mathematics Education Research Group of Australasia, Melbourne, pp. 483-490). Sydney: MERGA.

Lee, M. (1999). Education in Malaysia: Towards vision 2020. *School Effectiveness and School Improvement, 10*(1), 86-98.

Lewis R. Aiken, J. (1972). Language factors in learning mathematics. *Review of Educational Research, 42*(3), 359-385.

Lichtman, M. (2006). *Qualitative research in education: A user's guide.* London: Saga Publication, Inc.

Lim, C. S., & Chew, C. M. (2007, May 2007). *Mathematical communication in Malaysian bilingual classrooms.* Paper presented at the Third APEC-Tsukuba International Conference, Japan.

Lim, C. S. & Ping, Z.X. (2005, Aug. 2005). *Assessment and examination system: A comparative study between Malaysia and Shanghai (China).* Paper presented during the East Asian Regional Conference on Mathematics Education, Shanghai.

Lim, C. S., & Wun, T. Y. (2003, Oct. 2003). *Teaching mathematics in English: Are our mathematics teachers ready?* Paper presented at the International Conference on Science and Mathematics Education, University of Malaya, Malaysia.

Lin, A. M. Y. (1996). Bilingualism or linguistic segregation? Symbolic domination, resistance and code switching in Hong Kong schools. *Linguistics and Education, 8*, 49-84.

Loucks-Horsley, S., K. Styles, et al. (1996). Principles of effective professional development for mathematics and science education: A synthesis of standards. *National Institute for Science Education, 1*(1): 1-6.

Loucks-Horsley, S. (1995). Professional development and the learner centred school. *Theory into Practice, 34*(4), 265-271.

Loucks-Horsley, S., & Matsumoto, C. (1999). Research on professional development for teachers of mathematics and science: The state of scene. *School Science and Mathematics, 99*(5), 258-271.

Lucas, T., Villegas, A. M., & Freedson-Gonzalez, M. (2008). Linguistically responsive teacher education: Preparing classroom teachers to teach English language learners. *Journal of Teacher Education, 59*(4), 361-373.

Lyle, J. (2003). Stimulated recall: A report on its use in naturalistic research. *British Educational Research Journal, 29*(6), 861-878.

Mahathir, M. (1991). *Malaysia the way forward*. Kuala Lumpur: Institut Kajian Strategik dan Antarabangsa ISIS.

MacGregor, M. (1993*). Interaction of language competence and mathematics learning*. Melbourne: ACER.

Meaney, T. (2002). Symbiosis of cultural clash? Indigenous students learning mathematics. *Journal of Intercultural Studies, 21*(2), 167-187

Meaney, T. (2006). Mathematics register acquisition. *Set (3)* 39-43.

Meaney, T. (2005). *Mathematics as text.* Westport: CT: Information Age.

Meaney, T., Fairhall, U., & Trinick, T. (2007, July 2007). *Acquiring the mathematics register in te reo Maori.* Paper presented at the 30th annual Conference of the MERGA, Australia.

Merriam, S. B. (1998). *Case study research in education: A qualitative approach.* San Francisco: Jossey-Bass Publishers.

Merriam, S. B. (1998). *Qualitative research and case study Applications in education.* San Francisco: Jossey-Bass Publishers.

Miles, M. B. and A. M. Huberman (1991). *Qualitative data analysis: A sourcebook of new methods.* California: Sage Pub. Inc.

Ministry of Education Malaysia. (1996). *Education act 1996*. Kuala Lumpur: International Law Book Services.

Ministry.of.Education.Malaysia (2003). *Mathematics for integrated curriculum for secondary school: Curriculum specification form 2*. Kuala Lumpur: Curriculum Development Centre.

Mohamed, M., Nordin, A., & Hashim, R. (2007, Sept. 2007). Impact on the implementation of bilingualism in science and mathematics teaching in Malaysian school system. Paper presented at the Mathematics Education into 21st Century Project & The University of North Carolina 9th Annual International Conference, Charlotte.

Morse, J. M., M. Barett, et al. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods, 1*(1), 1-19.

Moschkovich, J. (2002). A situated and sociocultural perspective on bilingual mathematics learners. *Mathematical Thinking and Learning. 4*, 189-212.

Moschkovich, J. (2003, July 2003). *What counts as mathematical discourse?* Paper presented at the 25th PME Conference. Honolulu: University of Hawai'i. *3*, 325-332.

Moschkovich, J. (2005). Using two languages when learning mathematics. *Educational Studies in Mathematics, 64*, 121-144.

Moschkovich, J. (2007). *Bilingual mathematics learners: How views of language, bilingual learners, and mathematical communication affect instruction.* New York: Teachers College Press, Columbia University.

Muhamad, T. S. D. S. M. (2003, Dec. 2003) *Teaching science and mathematics in English: The way forward*. The ELTC ETeMS Conference: Managing Curricular Change, Kuala Lumpur.

Neuman, W. L. (2000). *The ethics and politics of social research.* (4 th. ed.). Australia: Allyn & Bacon.

Noraini Idris, L. S. C., Norjoharuddeen Mohd. Nor, & Saad, A. Z. A. R. a. R. M. (2007). The professional preparation of Malaysian teachers in the implementation of teaching and learning of mathematics and science in English. *Eurasia Journal of Mathematics, Science & Technology Education, 3*(2), 101-110.

Norzita, M. D. (2004). Tinjauan terhadap kesediaan guru dalam pelaksanaan pengajaran dan pembelajaran Sains dan Matematik dalam Bahasa Inggeris: Universiti Kebangsaan Malaysia.

Nunan, D. (2003). The impact of English as a global language on educational policies and practices in the Asia-pacific region. *TESOL Quarterly, 37*(4), 589-613.

Ong, S. L., & Tan, M. (2008). Mathematics and science in English: Teachers experience inside the classroom. *Jurnal Pendidik dan Pendidikan, 23*, 141-150.

Pandian, A., & Ramiah, R. (2003, Dec. 2003*). Mathematics and science in English teacher voices.* Paper presented at the ELTC ETeMS Conference: Managing Curricular Change, Kuala Lumpur.

Pang, V. (2005). The readiness on the use of English in the teaching of mathematics and science in Sabah: A case study of a primary school in a rural district. In Pandian, M. K. Kabilan & S. Kaur (Eds.), *Teachers, Practices and Supportive Cultures*. Serdang: University Putra Malaysia Press.

Patton, M. Q. (2002). Some guiding questions and options for methods decisions. In *Qualitative Research & Evaluation Methods, 3*, 13-29.

Pengelly, H. (1988). *Towards a mathematical way of thinking*. Adelaide: Intercom.

Petrova, J., & Novotna, J. (2007). *The influence of learners' limited language proficiency on communication obstacles in bilingual teaching/learning of mathematics.* Czech Republic: Faculty of Education, Charles University.

Pillay, H., & Thomas, M. (2003). The nation on the move: Challenges in the implementation of major change in language policy. *Asian Englishes, 6*(2), 26-43.

Pimm, D. (1987). *Speaking mathematically: Communication in mathematics classrooms.* London: Routledge and Kegan Paul.

Reeves, N. (1990). The mathematics-language connection. In BickmoreBrand (Ed.), *Language in Mathematics.* (pp. 90-99). Carlton South, Vic.: Australian Reading Association.

Richards, J. (1991). Mathematical discussions. In E. V. Glaserfeld (Ed.), *Radical constructivism in mathematics education.* (pp. 13-51). Dordrecht. The Netherlands: Kluwer Academic Publishers.

Rowe, V. C. (2009). Using video-stimulated recall as a basis for interviews: Some experiences from the field. *Music Education Research, 11*(4), 425-437.

Sam, H. K., Ting, L. N., & Hasbee, H. U. (2009). Status of mathematics teaching and learning in Malaysia. *International Journal of Mathematical Education in Science and Techonology, 40*(1), 59-72.

Setati, M. (2005). Teaching mathematics in primary multilingual classroom. *Journal for Research in Mathematics Education, 36*(5), 447-466.

Setati, M. (2008). Access to mathematics versus access to the language of power: The struggle in multilingual mathematics classrooms. *South African Journal of Education, 28,*103-116.

Setati, M., & Adler, J. (2000). Between languages and discourses: Language practices in primary multilingual mathematics classroom in South Africa. *Educational Studies in Mathematics, 43*, 243-269.

Setati, M., Adler, J., Reed, Y., & Bapoo, A. (2002). Incomplete journey: Code switching on other language practices in mathematics, science and English language classroom in South Africa. *Language and Education, 16*(2), 128-149.

Short, D. J., & Spanos, G. (1989). *Teaching mathematics to limited English proficient students*. ERIC Digests: ERIC Clearinghouse on Language and Linguistic Washington.

Sidhu, G. K. (2005). *Teaching mathematics in English: Issues and concerns in the Malaysian classroom*. Kuala Lumpur: UiTM.

Tan,Y. L. & Samyudia, Y(2009) Learning styles versus teaching styles: How to match them? *Teaching and Learning Open Forum*, Miri, Malaysia.

Van Oers, B. (2001). Educational forms of initiation in mathematical culture. *Educational Studies in Mathematics, 46*, 59-85.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge: MA, MIT Press and Wiley.

Wallace, M. (1998). *Action research for language teachers.* Cambridge: Cambridge University Press.

Walshaw, M. & Anthony, G. (2008). The teacher's role in classroom discourse: A review of recent research into mathematics classrooms. *Review of Education Research, 78*, 516-551.

White, D. Y. (2003). Promoting productive mathematical classroom discourse with diverse students. *Journal of Mathematical Behaviour*, *22*, 37-53.

Wood, D., Brunner, J., & Ross, G. (1979). The role of tutoring in problem solving. *Journal of Psychology and Psychiatry, 17*(2), 89-100.

Yahaya, M. F., Nor, M. A. M., Mokhtar, A. A., Rawian, R. M., Othman, M., & Jusoff, K. (2009). Teaching of mathematics and science in English: The teachers' Voices. *English Language Teaching, 2*(2), 141-147.

Yin, R. K. (2003*). Case study research: Design and methods.* California: Sage Publication, Inc.

Yuliati Y. (2008, Aug, 2008). *Scaffolding talks in teaching speaking based on social constructivism theory*. Paper presented at the 6th. Asia TEFL, Bali Indonesia.

Zazkis, R. (2000). Using code-switching as a tool for learning mathematical language. *For the Learning of Mathematics, 20*(3), 38-43.

APPENDIXES

Appendix 1: Research Activity.

Research Data Collection Activities.

Date	Events
School 1	
6 July 2009	Getting Research Pass from Prime Minister Department, Puterajaya, Malaysia.
13 July 2009	Meeting Education Officer at Pontian District Education Office, Johore. Briefing about the project. Identifying the school for the project.
14 July 2009	Meeting with the Headmaster of the school. Briefing the Headmaster about the project. Identifying the teachers for the project. School visit.
15 July 2009	Meeting with the teachers and students. Briefing the teachers and students. Distribute the approval form to teachers. Distribute the parent approval form to students.
16 July 2009	Interview 1 with the teachers. Getting teachers' teaching time table. Mock Videotaping.

17 July 2009	Getting students information from the school office. Mock Videotaping.
20 July 2009	Getting the approval from teachers and students. Mock Videotaping.
21 July 2009	Discussion with teachers on the methods Mock Videotaping.
22 July 2009	Videotaping 1 Amirah. Discussion with Amirah.
23 July 2009	Videotaping 1 Aisyah. Discussion with Aisyah.
24 July 2009	Stimulus Recalled with Amirah. Stimulus Recalled with Aisyah.
27 July 2009	Videotaping 2 Aisyah. Discussion with Aisyah.
28 July 2009	Stimulus Recalled with Aisyah
30 July 2009	Videotaping 2 Amirah Discussion with Amirah
31 July 2009	Stimulus Recalled with Amirah
3 August 2009	Videotaping 3 Aisyah Discussion with Aisyah

5 August 2009	Stimulus Recalled with Aisyah
6 August 2009	Videotaping 3 Amirah Discussion with Amirah
7 August 2009	Stimulus Recalled with Amirah Meeting Headmaster and teachers

School 2

17 August 2009	Meeting Education Officer at Sungai Petani District Education Office, Kedah, Malaysia. Briefing about the project. Identifying the school for the project.
18 August 2009	Meeting with the Headmaster of the school. Briefing the Headmaster about the project. Identifying the teachers for the project. School visit.
19 August 2009	Meeting with the teachers and students. Briefing the teachers and students. Distribute the approval form to teachers. Distribute the parent approval form to students.
20 August 2009	Interview with the teachers. Getting teachers' teaching time table. Mock Videotaping.
School Holiday 21-29 August 2009	

30 August 2009	Getting students information from the school office. Mock Videotaping.
31 August 2009 National Day Holiday	
1September 2009	Getting the approval from teachers and students. Mock Videotaping
2 September 2009	Discussion with teachers on the methods Mock Videotaping
3 September 2009	Videotaping 1 Amni Discussion with Amni
6 September 2009	Videotaping 1 Aryana Discussion with Aryana
7 September 2009	Stimulus Recalled with Amni
8 September 2009	Stimulus Recalled with Amni
9 September 2009	Videotaping 2 Aryana Discussion with Aryana
9 September 2009	Stimulus Recalled with Aryana
10 September 2009	Videotaping 2 Amni Discussion with Amni

13 September 2009	Stimulus Recalled with Amni
15 September 2009	Videotaping 3 Aryana Discussion with Aryana
16 September 2009	Stimulus Recalled with Aryana
17 September 2009	Videotaping 3 Amni Discussion with Amni
20 September 2009	Stimulus Recalled with Amni
21 September 2009	Meeting Headmaster and teachers

Note: 21-29 August is school semester break & 31 August is public holiday

Appendix 2: Pre-Observation Interview Questions.

- What is your name?
- How old are you?
- How long have you been teaching mathematics?
- How long have you been teaching mathematics in English?
- What sort of professional development have you attended related to teaching mathematics in English?
- Do you find the course you attended useful? How?
- What do you think of teaching mathematics in English?
- Do you enjoy teaching mathematics? Why?
- What do you find most challenging in teaching mathematics in English?
- Do you prefer to teach in Bahasa Malaysia or English?
- Are you aware that there is specific language used only in communicating mathematics ideas?

Appendix 3: Sample of Transcribing 1 (Amirah)

Transcription 1

Teacher Amirah Female 30 years old years teaching experience

School 1 Class 4 E 10 years old 36 students

Physical Setting: Students are seated at their own chair n desk.

Topic: Shapes & Perimeter

Transcription	Descriptive notes	Reflective notes	Resources
Good morning class Close your book close *tutup* Okay 10 x 2 Lis (20) 20 good 5 x 20 yes Amirul (100) that's good 12 x 6 Lam (72) 72 yes good 10 x 10 Siti Alifah (100) 100 yes good 9 x 9 Norizwani (81) 81 good 12 + 7 12 + 7 Zack (19) Yes 19 good 100 -50 Lee (50) 50 good 50 – 25 Adib (25) 25 yes good	T begins the class by doing quick review of times table and quick sums. Calling names of individual students.	It is the habit for teacher to use L1 Reviewing the previous lesson	

75-50 75-50 yes Safie (25) 25 yes good 50 + 35 50 + 35 Darsen (85) 85 yes good 150 + 10 150 + 10 Nadia (160)160 ok very good So we go to new topic today. Tell me what is this shape – square Are you sure – yes Why do you say this is a square? Cause it has 4 equal sides Can you repeat yes (4 equal sides) sizes? sides Side *ialah sisi* 1 2 3 4 one side. This is a square Square has equal sides. *4 sisi yang sama* square All of you square square square This next shape Okay, what do you call this shape?	T shows a square made of cardboard. T pastes the square on the board Asks students to repeat	Repeating the word side/ stress on pronunciation distinguish between sizes and sides- plural emphasis L1 being used to emphasis important fact.	Shapes from cardboard

Rectangle Why do you say this is a rectangle? This shape still have 4 sides but What is the difference here? Haa..2 long sides Here *sisi yang panjang* What about the other, these 2 sides (short) 2 short sides We call rectangle rectangle, rectangle Another one shape What do you call the shape Triangle How many sides here 3, 1 2 3 3 sides We say edge *kalau satu* edge one edge More than one we call edges So now if I…	T pastes the rectangle on the board. T pastes the triangle on the board	Direct translation. T introduces the new term. Repeat the new term introduced. Emphasis on language grammar by explaining the plural and singular Concept in L1 &	

The first shape here This is shape A, B and shape C What do you call the shape? Square Okay, if I give you one side here is 7 cm Example we use a ruler All of you must have your own ruler like this And you try to measure this shape Try one side okay *Satu* side *dulu* *Satu sisi* Here I have 15 cm okay Before you measure make sure we start from 0 *Mula dengan 0 dulu jangan tengah tengah* You must start from 0 Here I have 15 cm okay How about the 2nd side? also 15 cm How about here? Also same 15 cm And the last one 15 cm So you must know each each what? each sides Okay then to know what is the total of all the sides	T demonstrates SS how to measure the sides using a ruler (complex instruction)	L2 T used L1 to explain the steps taken to measure the sides using ruler.	

Okay you have two ways to solve this situations How to find the total of the sides *Tahu jumlah* total of the sides *semua sisi* You must plus 15 cm, 15 cm, sides 15 cm and another 15 cm okay You have the same unit okay 5, 5, 5, 5, 20, 1, 1, 1, 1, 4 + 2 is 6 So you have the total of the sides is 60 cm Or another one way Here 4 same sides So one side is 15 cm so times 4 1, 2, 3, 4 x 4 cm, cm 4 x 5 = 20 1 x 4 + 2 so you must have the same answer You must choose the first way or the second way This is multiplication concept okay Now look at second shape This is what? Rectangle okay Now I still use the ruler okay to measure the length here	Important facts about calculating perimeter T writes the addition on the board and solve it with students 15 cm 15 cm 15 cm + 15 cm -------- 60 cm T shows how to calculate the perimeter of the rectangle 15 cm X 4 ------ 20 cm	Awkward expression- another way	

Okay these 2 sides are the same okay Okay now I have 15. What this side is- 15 30 cm. this is the same the other side 30 cm How about here? 15 + 11 15 + 11, 26 cm Okay what 26 also How to find the total of all the sides What number you must plus here 30 cm, next 30 cm okay, plus 26 cm and other one 26 cm okay Cm ok, 12, 3+3+2 +2+1 okay 11 The final answer 112 what, cm. This is the way to find the total of edges of the sides or edges. *Luar sahaja*, outside And the last shape What is the shape?- triangle okay example here What is this? (*sama sisi*) Example here I use this ruler and I get a 15 cm	T shows how to add the perimeter 30 30 26 + 26 ----- 112 cm Points to 2 sides of the triangle that have same length.	Direct translation habit Student responds correctly in L1.	

How about this? Also same Here is 15 cm, here also 15 cm How about the base? Base is different 15 + 15 is what, 30 + 4 = 34 cm Here you find the total of all sides Okay plus, 15 cm then 15 cm + 34 cm okay okay, 14, 1 + 1 + 1+3 then final answer 64 cm Do you understand? Okay When you want to find the total of all sides you must plus all the sides aah.. *ialah sisi* or we can called edges Okay so this way we call to find what This one we call perimeter, understand aah okay After you plus all the sides, we call perimeter This is the way we find the perimeter This is the basic yer okay Now I changed all the numbers here okay But Im still use the same shape This is the square, square must have the same sides,	T writes the addition on the board and solves it with students 15 cm 15 + 34 ------ 64 cm T changes the measurement of each shape	Awkward expression-also same Use L1 for explanation	

Okay so here I give here 7 cm Okay, this is the rectangle, the length here I give you 8 cm, edge here 4 cm okay Triangle one side I give you 6.5 cm And the base here 10.5 cm Okay I need you to find the perimeter of each shapes The person, Lam Second shape Darshan The last shape for Noriswani *(Macamana cikgu)* You must know each side This is the first side How about 2, 3, and 4 How many sides ..Aaahh You have 4 same sides isn't it. So 1, 2, 3, put another one side Okay class look at the blackboard	Selects to individual SS to do the exercise on the board. SS asks T how to do the question. T explains to student who asks for clarification on how to do the exercise given.	Awkward expression-give T used English to explain SS speak different L1 but she is asking in Malay	

Look at the first question Correct? (yes) The square. Make sure you must know the length of each side. Okay you must plus or you can times 7 + 7 she got 14 cm correct 14 + 7 she got 21 cm Plus another 7 cm, she get 28 cm Okay so the final answer is 28 cm Or you can do that one? 7 x 4 how many side? 1,2,3,4 any problem here? 7 x 4 28 okay How about the second shape 4 + 4 , 8 + 8 correct And the total all the number here he got 24 cm Correct? Good And the last shape	T explains the working for question 1		

6.5 cm + 6.5 cm = 13.0 x 3 cannot you x 2 4 x 2 this is the same 4 cm how many same sides here 4 x 2 How about this two sides 8 cm x 2 8 x 2 what … 16 cm Then you can plus 8 + 16, 24 understand okay (4 + 4 = 8) 4 + 4 is 8 Here 8, 8 x 3 you get 24 cm Oh…also can 4 + 4 8, 8 x 3 24 cm The last one 13.0 cm then plus another one side Here 23.5 cm Okay very good This is the single shape. Aaah single shape Now I want to combine the shapes We call composite shape.	T points out that there is another way of calculating the answer for the previous shape so T goes back to previous exercise.	Awkward expression-how many same sides? Awkward expression- also can	

Not transformers?? *Katun la tu* Okay now I combine the shapes *gabung* Combine shapes *maksudnye saya gabungkan bentuk yang sama dalam satu bentuk* For example, for shape (a), I have 2 squares here. Okay how to find the perimeter What must you plus? Okay perimeter make sure you know the meaning of perimeter *Keseluruhan,* total one Yes total of outside the edges or sides This is very important outside *luar sahaja ukurlilit* perimeter *dalam bahasa Malaysia Ukur keliling* total outside of edges only, *yang luar sahaja* you must use your pencil, then you must underline you must follow 1, 2, 3, 4 this is call perimeter understand , which one is the outside and just outside of edges, *yang luar sahaja* example here, I give you 8 cm	Responding to SS comments on the shape. T paste another shape to the shape on the board T write the word total on the board, trying to get SS to provide the meaning of perimeter	T made a joke in L1 Intentionally explaining how composite shape is form in L1 Give the meaning of perimeter in L1	

okay all the sides are the same so how to find the perimeter? Teo One side here is 8 cm. how about each side here? Theses sides also 8 cm, *kena tulis dulu*, you must write first Here is 8 cm, next side is 8, here, here and last one. How to find the perimeter for this shape? You can times What x what? 8 x 6 1 2 3 4 5 6 After 5-8 1 2 3 4 5 6 okay Look at the second shape Okay one shape we called rectangle I combine this rectangle Then I write here, like this What meaning of this symbol? If I write down here 7.3 cm Okay how about here, how long.. this edge (*sama cikgu*) Ha..this side is same with this side how long here 7.3 cm	T pointing to the ideas T puts the symbol of equal length on each sides of the triangle	Habit direct translation Grammar-omission of 'is'. SS respond in L1	

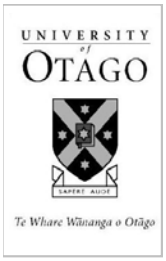
Which one we call the perimeter? You must draw the line. Start from here All this one we call perimeter perimeter This side here 10 cm, how about this side, 10 cm. This also 10 cm here and the last one understand? Can you plus total this side? No Perimeter outside only. And the last one, diamond Ok one side I give you 4.2 cm (*sama, sama*) Aaah all the side are same 4.2 cm 4.2 cm here also same 4.2 cm How to find the perimeter? What? You must clear outside line here Okay how to find the perimeter? You must draw what? I need you to solve these questions Question (a)	T demonstrates by drawing the line outside the shape on the blackboard. T points to where she combine the shapes T assigned 3 SS to do the exercise on the board	SS respond in L1	

The answer is correct or not? 8 x 6 48 Correct The final answer she got 48 cm, correct Why she x 6, the sides, 6 (6 sides) Or you can plus very good Look at (b) 7.3 x 2 Why times 2? we have 2 same sides So times 2 7.3 x 2 she get 14.6 cm You must write cm 10 x 4 cannot 1, 2, 3, 4 you have 40 cm then plus 54.6 cm Very good The last one 4.2 + 4.2 + 4.2 + 4.2 Okay the final answer is 16.8 cm Another one way Or 4.2 cm x 4	T pointing at the exercise		

1, 2, 3, 4 you have 4 same sides 2 x 4 8 , 16 you have same answer Understand? Yes So if you understand, okay Okay all of you please look at the activity sheet now Okay measure and write the perimeter of the following composite of the shape You must measure all the sides and then you find the perimeter. you must use your ruler You must draw the frame first; the line then you detects how to find the perimeter.	T distributing the work sheet to the students SS doing individual work	Awkward expression- cannot	
T uses lots of blackboard L1 repetitive similar sentence structure simple language and instruction At times not grammatically accurate			

Use of first language for different reasons Explanations of word Use of direct translation For instruction Explain concepts and important facts Habits Coding Process Maths & Non Maths Language Maths language Procedural- describe steps taken during maths Conceptual- explain reasons for calculating Non Maths language Regulatory- regulate behavior n instruction Contextual- focus on the context of maths task under discussion		

Appendix 4: Information Sheet for Participants.



College of Education
University of Otago

Teaching of Mathematics in Second Language
In Malaysian Primary Schools

INFORMATION SHEET FOR
PARTICIPANTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you of any kind and we thank you for considering our request.

What is the Aim of the Project?

The project is being undertaken as part of the requirement for the degree of Doctor of Philosophy at University of Otago, New Zealand. The researcher, Ahmad Sabry Othman, is a PhD candidate being supervised by College of Education. The aim of the project is to gather data pertaining the language used by mathematics teachers in teaching mathematics in second language.

What Type of Participants are being sought?

To attain the aim mentioned above, the researcher will carry out classroom observation of mathematics teachers who are currently teaching at primary schools in Malaysia.

What will Participants be Asked to Do?

Should you agree to take part in this project, you will be videotaped while teaching mathematics to year 4 classes over the period of a week (approximately 200 minutes).

Please be aware that you may decide not to take part in the project without any disadvantage to yourself of any kind.

Can Participants Change their Mind and Withdraw from the Project?

You may withdraw from participating in the project at any time and without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?
Tapes of your lesson will be transcribed. Intensive analysis will be made to identify the language features present. This will serve as the basic for recommendation to improve teaching strategies in teaching mathematics in second language.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

You are most welcome to request a copy of the results of the project should you wish.

The data collected will be securely stored in such a way that only those mentioned above will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

Reasonable precautions will be taken to protect and destroy data gathered by email. However, the security of electronically transmitted information cannot be guaranteed. Caution is advised in the electronic transmission of sensitive material.

What if Participants have any Questions?
If you have any questions about our project, either now or in the future, please feel free to contact either:-

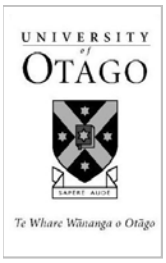
Ahmad Sabry Othman
Post Grad Room
College of Education
University Tel Number: - 03-4795975
amadsabry@yahoo.com

or

Dr Mary Simpson
College of Education,
Otago University
University Tel Number:- 03-4798814
mary.simpson@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix 5: Information Sheet Parents and Students.



College of Education
University of Otago

Teaching of Mathematics in Second Language
In Malaysian Primary Schools

INFORMATION SHEET FOR
PARENTS/STUDENTS

Thank you for showing an interest in this project. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate I thank you. If you decide not to take part there will be no disadvantage to you of any kind and I thank you for considering our request.

What is the Aim of the Project?

The project is being undertaken as part of the requirement for the degree of Doctor of Philosophy at University of Otago, New Zealand. The researcher, Ahmad Sabry Othman, is a PhD candidate being supervised by College of Education. The aim of the project is to gather data pertaining the language used by mathematics teachers in teaching mathematics in second language.

What Type of Participants are being sought?

To attain the aim mentioned above, the researcher will carry out classroom observation of mathematics teachers who are currently teaching at primary schools in Malaysia. The main focus is on the teachers. However, your child will be involved as his/her teacher has already agreed to participate.

What will Participants be Asked to Do?

Should you agree to let your child participate in this project, he/she together with his/her classmates will be videotaped during the mathematics lesson for of a week.

The main participant is the teachers and your child will not be filmed and the comment will not form any part of the data

Can Participants Change their Mind and Withdraw from the Project?

Your child may withdraw from participating in the project at any time and without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?
Tapes of the lesson will be transcribed. Intensive analysis will be made to identify the language features present. This will serve as the basic for recommendation to improve teaching strategies in teaching mathematics in second language.

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve your anonymity.

The data collected will be securely stored in such a way that only those mentioned above will be able to gain access to it. At the end of the project any personal information will be destroyed immediately except that, as required by the University's research policy, any raw data on which the results of the project depend will be retained in secure storage for five years, after which it will be destroyed.

What if Participants have any Questions?
If you have any questions about our project, either now or in the future, please feel free to contact either:-

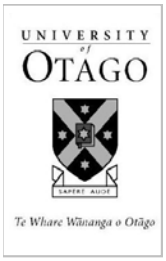
Ahmad Sabry Othman
Post Grad Room
College of Education
University Tel Number: - 03-4795975
amadsabry@yahoo.com

or

Associate Professor Mary Simpson
College of Education,
Otago University
University Tel Number:- 03-4798814
mary.simpson@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix 6: Consent Forms for Participants.



College of Education
University of Otago

Teaching of Mathematics in Second Language
In Malaysian Primary Schools

CONSENT FORM FOR PARTICIPANTS

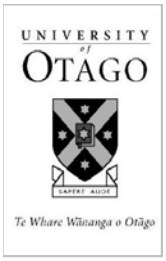
I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.
I know that:-
1. My participation in the project is entirely voluntary;
I am free to withdraw from the project at any time without any disadvantage;
Personal identifying information [*video-tapes / audio-tapes*] will be destroyed at the conclusion of the project but any raw data on which the results of the project depend will be retained in secure storage for five years, after which they will be destroyed;
The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

I agree to take part in this project.

.....
.....
(Signature of participant) (Date)

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix 7: Consent Form for Parents/Guardians.



Teaching of Mathematics in Second Language
In Malaysian Primary Schools

CONSENT FORM FOR PARENTS / GUARDIANS

I have read the Information Sheet concerning this project and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage. Hereby, I give my consent for my child to be involved in this project.
I know that:-

1. This project involves videotaping the child's teacher. The child will not be filmed and the comment will not form any part of the data;

2. My child can be withdrawn from the project at any time without any disadvantage;

3. Personal identifying information [*video-tapes / audio-tapes*] will be destroyed at the conclusion of the project;

The results of the project may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity.

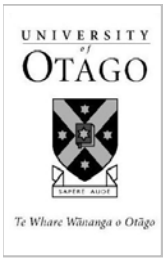
I agree my child to take part in this project.

....
(Signature of parents/guardian) (Date)

This study has been approved by the University of Otago Human Ethics Committee. If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256). Any

issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Appendix 8: Consent Forms for Parents/Guardians in Bahasa Malaysia.



College of Education
University of Otago

Pengajaran Matematik di dalam Bahasa Inggeris
di Sekolah Rendah di Malaysia

Borang Kebenaran Ibubapa /Penjaga

Saya telah membaca dan memahami isi kandungan berkenaan projek penyelidikan ini. Semua pertanyaan telah pun dijawab dengan jelas. Saya difahamkan bahawa saya boleh memohon apa-apa maklumat mengenai projek ini sepanjang tempoh penyelidikan dijalankan. Saya bersetuju agar anak saya terlibat di dalam projek ini
Saya dimaklumkan bahawa:-

1. Projek ini melibatkan videotape pengajaran guru sahaja. Anak saya tidak akan terlibat di dalam videotape ini;

2. Anak saya dibenarkan menarik diri dari projek ini tanpa perlu bimbang tentang apa-apa tindakan;

Segala maklumat peribadi akan dimushankan selepas selesai projek tersebut..

Hasil projek ini akan diterbitkan dan boleh didapati dari Perpustakaan University of Otago, Dunedin, New Zealand tetapi segala maklumat persendirian hendaklah dilayan sebagai maklumat sulit.

Dengan ini saya bersetuju anak saya terlibat di dalam projek penyelidikan ini.

....
Tandatangan dan nama penuh Tarikh